1.0 Introduction

1.1 What ChemWell does

ChemWell is a computer controlled instrument system, capable of automating any or all stages of assay processing that involve these functions:

fluid handling	aspirating and dispensing from 2 uL to 2.5 mL
incubating	heating to 25°C or 37°C: probe/coil to 37°C or ambient, and reaction plate to 25°C, 37°C, or ambient.
mixing	reaction plate only
strip washing	8-wells simultaneously
timing	from 1 sec to 24 hours
optical reading	UV/Visible range
calculating	using numerous preprogrammed equations
data storage	unlimited capacity
and reporting	with many options and customization to choose from.

The system allows you to define and program an unlimited number of customized protocols by selecting displayed menu options from a Microsoft Windows[1] software program. This open system can be programmed to perform any of the colorimetric biochemistry assays or EIA assays that can be handled using the volumes, temperatures, and wavelengths provided. It has many possible applications in clinical and veterinarian testing, environmental testing, food and water analysis, life science research, and may also be used in production processes involving micro volume dispensing, diluting, incubating, reading, washing, and so on.

ChemWell is a unique combination of an automatic chemistry system and an automated EIA system, two instruments in one.

Reactions occur in standard plastic microwells instead of sample cups or a carousel. Microwell strips and plates are commercially available from many sources. Place your reagent bottles and sample tubes into the removable instrument racks. Then program the instrument to pick up from one place, dispense to another, wash the probe, wash the plate, read the wells, incubate, mix, or whatever you want it to do. When doing chemistry reactions, groups of four wells are timed simultaneously. Rows of 8 are timed together to coordinate EIA processes.

[1] Microsoft, Microsoft Windows, Windows 95/98, Windows NT 4.0, are registered trademarks of Microsoft Corporation.

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ChemWell is not dedicated for use with any particular chemical reaction, method, or manufacturer. This gives you many advantages including great flexibility in how you use it. Your lab decides how to set up your racks and plates, which reagents you will use, how many controls you will run, how many different applications you want on it, and so on. This also means that the instrument must first be programmed before each new application. To assure the quality of clinical information, each new setup must be validated before reporting specimen results. In some cases the programming, optimization, and validation may have already been done. Before applying any new clinical reagent system, check first with the diagnostic reagent manufacturer for specific instructions, validation information, and application tips. You are also advised to run specimens having known concentrations to verify your instrument setup parameters. After that, programs can easily be recalled for review, use, change, or deletion by you. You decide everything including how manual and how automatic you want your system to be.

Awareness Technology, Inc. developed ChemWell instruments and software as tools for the modern global laboratory. The power and freedom to apply ChemWell, is completely yours.

1.2 Warnings and Precautions

WARNING
FOR IN-VITRO DIAGNOSTICS USE

Some diagnostic assays utilize materials which are potentially biohazardous. Always wear protective apparel and eye protection while using this instrument. Always operate the instrument with the aerosol shield lowered.

Do not use the instrument in a manner not specified by the manual, or the protection provided by the instrument may be impaired.

Probe tips are sharp and may cause bodily injury. Do not place hands or fingers under the probe or wash head probes while instrument is in operation. Always set the power switch to OFF (0) before working on the probe or wash head. Never touch the probe or wash head while the instrument is operating.

WARNING: The probe performs a self clean periodically while the probe is idle. Keep hands away from the probe at all times if instrument power is ON (1).

If the waste bottle is overturned during operation, immediately set the power switch to OFF (0). If the hydrophobic filter becomes wet due to an overturned waste bottle, it will be blocked. Continued use of a blocked filter will impair washer effectiveness and/or result in damage to the instrument.

The wash and rinse bottles are pressurized during normal operation. Do not remove bottle caps or tubing connections while the bottles are pressurized. Turn off the instrument before changing bottles, adding more solution, or tubing connections.

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Solvents such as acetone or thinner will damage the instrument . Do not use solvents to clean the unit. Avoid abrasive cleaners; the aerosol shield is liquid-resistant, but is easily scratched.

The exterior of the instrument may be cleaned with a soft cloth using plain water. If needed, a mild all-purpose or non-abrasive cleaner may be used. A 10% solution of chlorine bleach (chlorine bleach= 5.25% Sodium Hypochlorite) or 70% isopropyl alcohol may be safely used as a disinfectant. Take special care not to spill liquid inside the instrument.

Particulate matter in wash solutions can clog washer probe head easily. See the section on cleaning the probe head for special instructions on removing particulate matter from clogged washer heads.
Please take time to read this manual carefully before using the instrument. For best results, familiarize yourself with the instrument and its capabilities before attempting any clinical diagnostic tests. Refer any questions to your instrument dealer.

Retain the original packing material for future use in the event that the instrument is placed in storage, shipped to another location, or returned for service. Two people or more should lift the instrument by placing hands under the side panels and lifting.

ChemWell should be installed on a sturdy, level, surface capable of supporting the instrument's weight (45 kg) safely, The instrument should be surronded by the following clearances: 46cm on each side, 117cm on top, 15cm front, and 18cm back. ChemWell requires no fastening to the bench top.

IMPORTANT OPERATING PRECAUTIONS!

The quality of washing often affects the validity of test results. To assure adequate washing:
- **Perform periodic dispense volume repeatability checks as described in this manual.**
- **Rinse the wash head and probe after use.**
- **Handle and store the wash head carefully to prevent damage.**
- **Use the prime cycle before each wash.**
- **Watch the instrument to see that the probe and wash head dispense is functioning properly.**

Be sure to run a sufficient number of controls in each assay. If controls are not within their acceptable limits, or if you suspect incomplete or non-uniform washing, disregard test results.

Do not operate the instrument if the pressure is unstable or if the probe or wash head probes are damaged.

1.2.1 Intended Use

FOR IN-VITRO DIAGNOSTIC USE

The ChemWell is designed for use in processing general chemistry and enzyme-linked immunosorbent assays ("ELISA" or "EIA"), including clinical diagnostic assays, requiring multistep washing, rinsing, and soaking. This general purpose instrument is intended to be used by laboratory professionals who

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are capable of selecting the appropriate features and options for each specific clinical application.

1.2.2 General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this instrument or any products connected to it. To avoid potential hazards, use this instrument only as specified.

WARNING: Only qualified personnel should perform service procedures. Contact your dealer to arrange factory training.

1.2.3 To Avoid Fire or Personal Injury:

• **Use Proper Power Cord.** Use only the power cord specified for this product and certified for the country of use.

• **Ground the Product.** This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. An optional method is to attach a ground strap from the external grounding terminal on the rear panel of the instrument to a suitable ground such as to a grounded pipe or some metal surface to earth ground. See figure 1.3.4.

• **Observe All Terminal Ratings.** To avoid fire or shock hazard, observe all ratings and markings on the instrument. Consult this manual for further ratings information before making connections to the instrument.

• **Do Not Operate Without Covers.** Do not operate this instrument with covers and panels removed.

• **Use Proper Fuse.** Use only the fuse type and rating specified for this instrument.

• **Avoid Exposed Circuitry.** Do not touch exposed connections and components when power is present.

• **Do Not Operate With Suspected Failures**. If you suspect there is damage to this instrument, have it inspected by a qualified service person.

• **Provide Proper Ventilation**. Refer to the installation instructions for details on installing the product so it has proper ventilation.

• **Do Not Operate in Wet/Damp Conditions.**

• **Do Not Operate In An Explosive Atmosphere.**

• **Keep Instrument Surfaces Clean and Dry.**

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1.2.4 Safety Terms and Symbols

Terms in This Manual. These terms may appear in this manual:

Warning: Warning statements identify conditions or practices that could result in injury or loss of life.

Caution: Caution statements identify conditions or practices that could result in damage to this product or other property.

Terms On the Product. These terms may appear on the product:

DANGER indicates an injury immediately accessible as you read the marking.

WARNING indicates an injury hazard not immediately accessible as you read the marking.

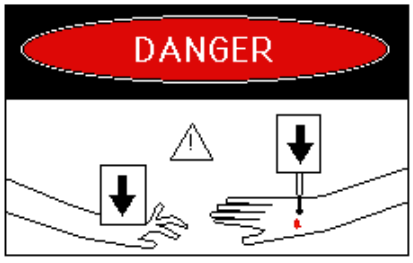
CAUTION indicates a hazard to property including the product.

Symbols on the Product.

These symbols may appear on the product:

WARNING Risk of Shock	Protective Ground (Earth) Terminal	CAUTION Refer To Manual	BIOHAZARD Risk of Infection

FUSE: For continued protection against risk of fire, replace only with fuse of the specified type and current ratings. Disconnect equipment from supply before replacing fuse.



DANGER: PINCH POINTS, SHARP POINTS, AND MOVING PARTS- Mechanisms may operate without warning.

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1.3 Layout

Figure # 1.3.1 and 1.3.2 show the exterior of the instrument, Figure # 1.3.3 shows the right side panel, and Figure #1.3.4 shows the Rear Panel layout. For clarity of illustration, the aerosol shield is not shown in Figure #1.3.1.

The sub-assemblies are as listed.
Plate X Mover Figure #1.3.5
Plate Y Mover Figure #1.3.6
Plate X and Y Movers are combined and are responsible for the plate carrier movement.

Rack Y Mover Figure # 1.3.7 is responsible for the sample and reagent rack's movement.

Probe X Mover Figure #1.3.8
Probe Z Mover Figure #1.3.9
Probe X and Z Movers are combined and are responsible for the probe movement.

Washer Figure #1.3.10 is responsible for the aspiration and dispensing of liquids using the wash head.

Electronics Rack Figure #1.3.11 holds the main boards (PCAs) and the power circuitry.

Pressure and Valve Bracket Figure #1.3.12 controls the fluid flow of the washer.

Syringe Pump Figure #1.3.13 controls the fluid flow of the probe.

Photometer Figure1.3.14 houses the lamps, filters, and is responsible for photometric readings.

Bottles Figure #1.3.15 holds liquids for the washer system.

ChemWell Coordinate System Figure #1.3.16 explains the coordinate system for ChemWell.

WARNING: Hazardous line voltages are present behind the AC cover and on the power supplies. Always disconnect the external AC power cable before servicing the instrument.

WARNING: The operation of ChemWell may involve the use of biohazardous material. Refer to the Owner's Manual for biohazard warnings.

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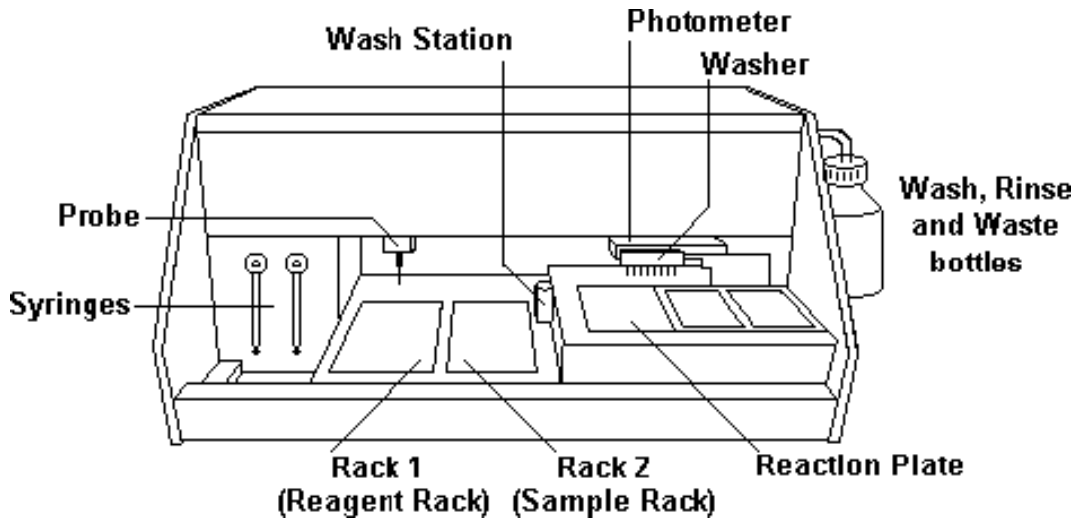

Figure #1.3.1 Instrument Exterior (without aerosol shield)

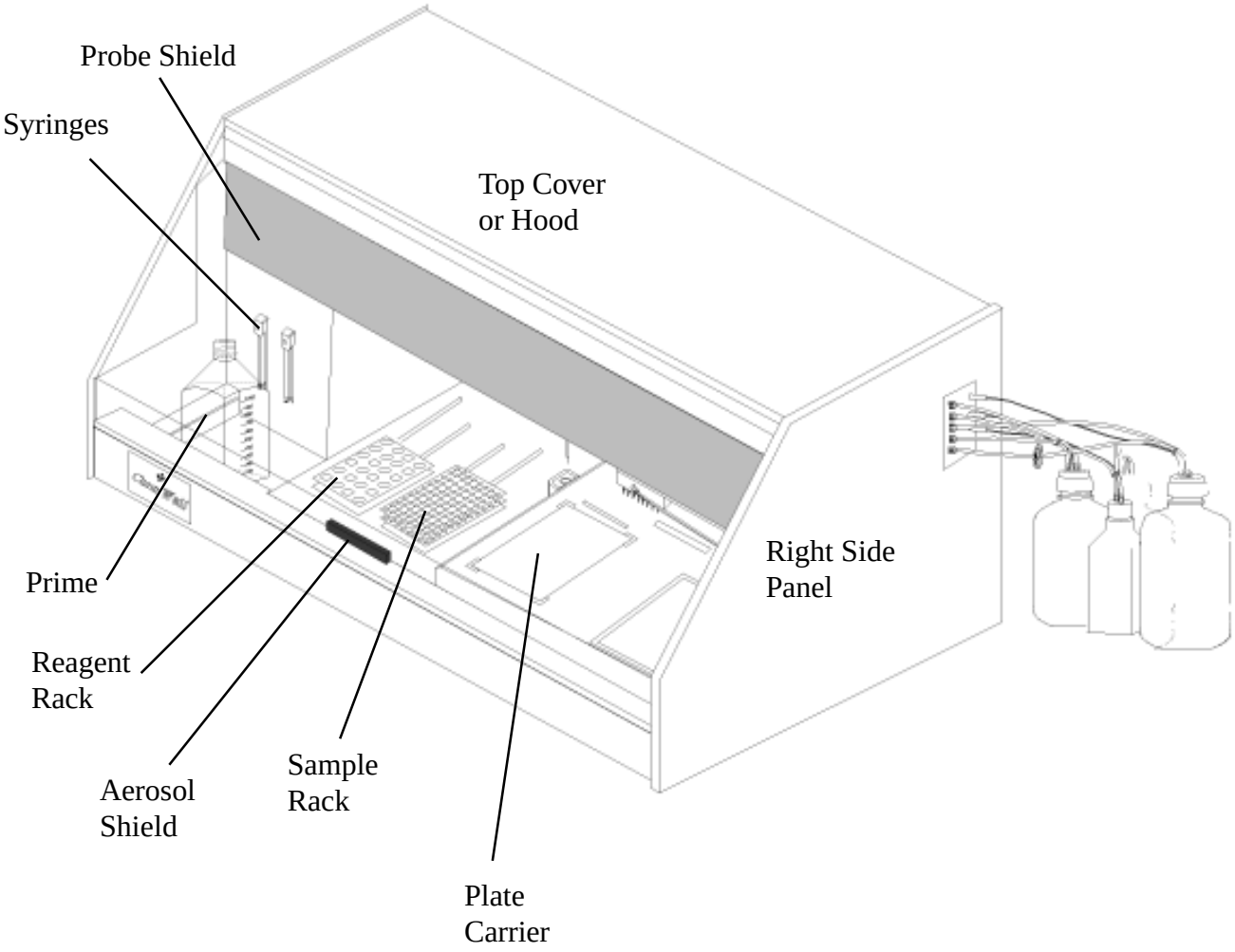

Figure #1.3.2 Instrument Exterior (aerosol shield translucent and syringe tubing not shown)

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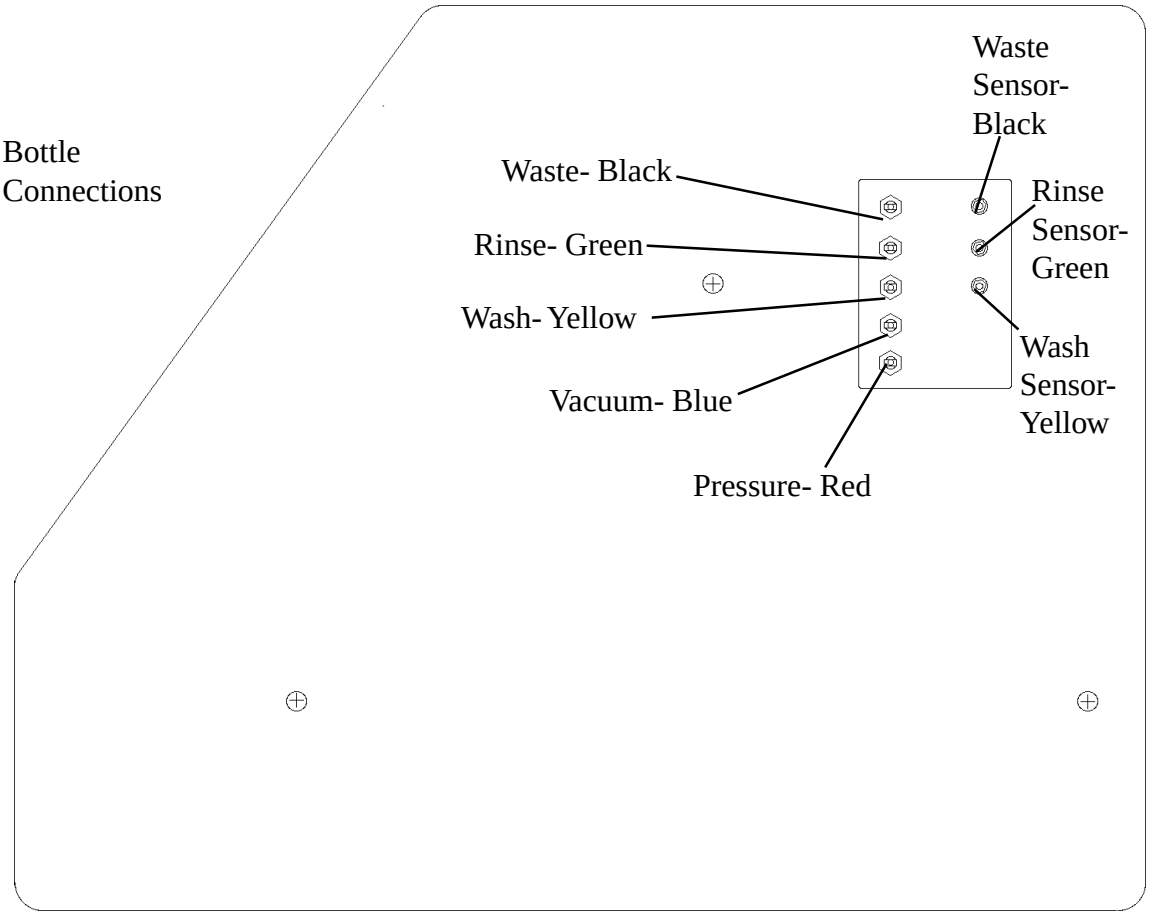

Figure #1.3.3 Right Side Panel Showing Bottle Set Connections

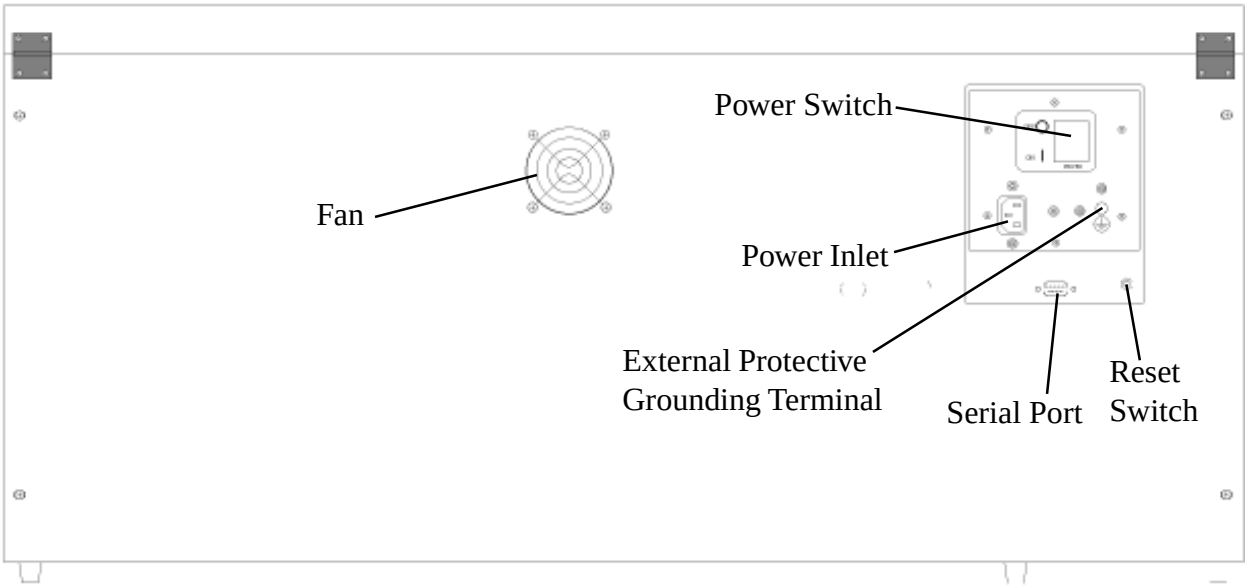

Figure #1.3.4 Rear Panel

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Plate X Mover

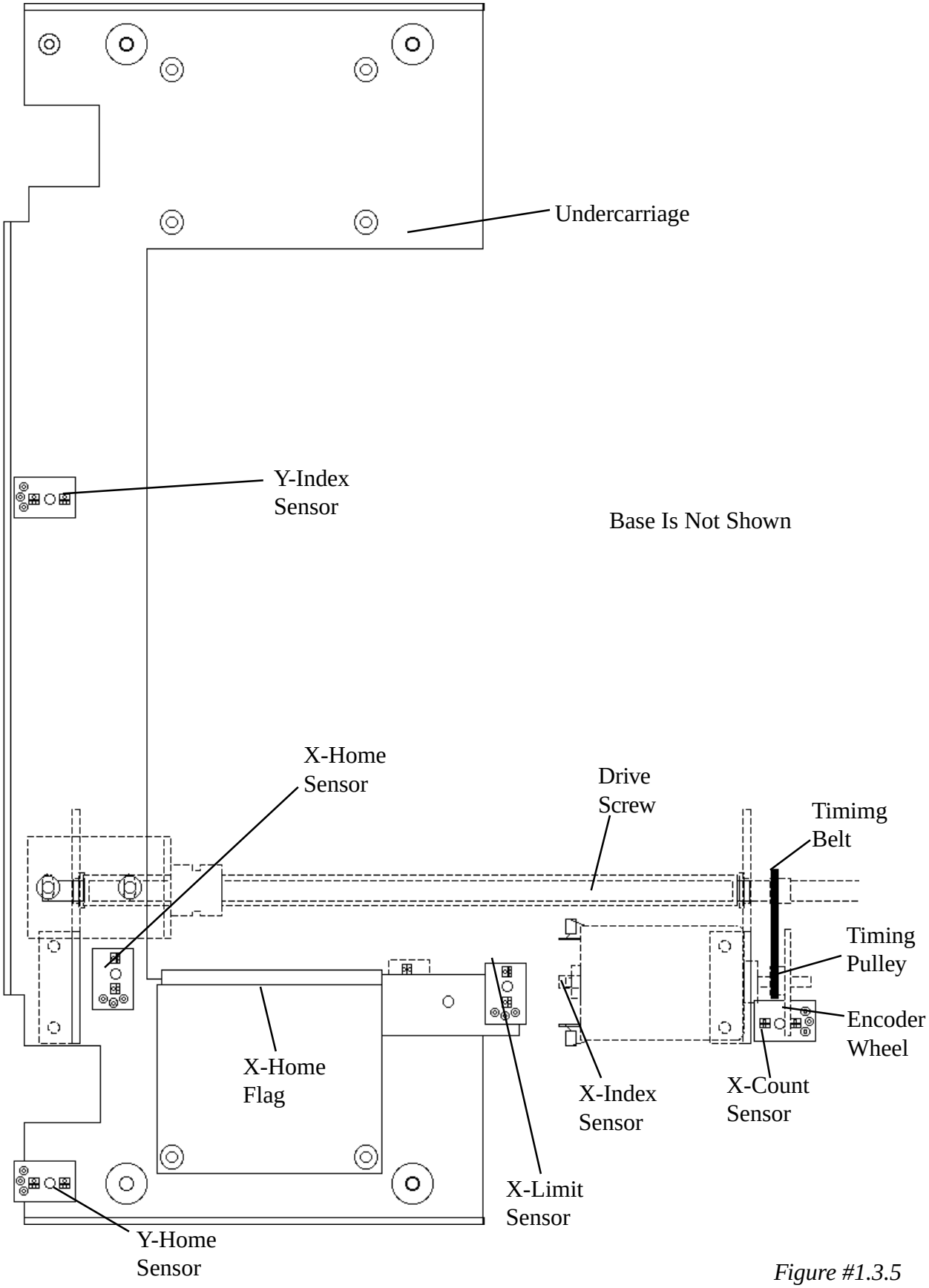

Figure #1.3.5

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Plate Y Mover

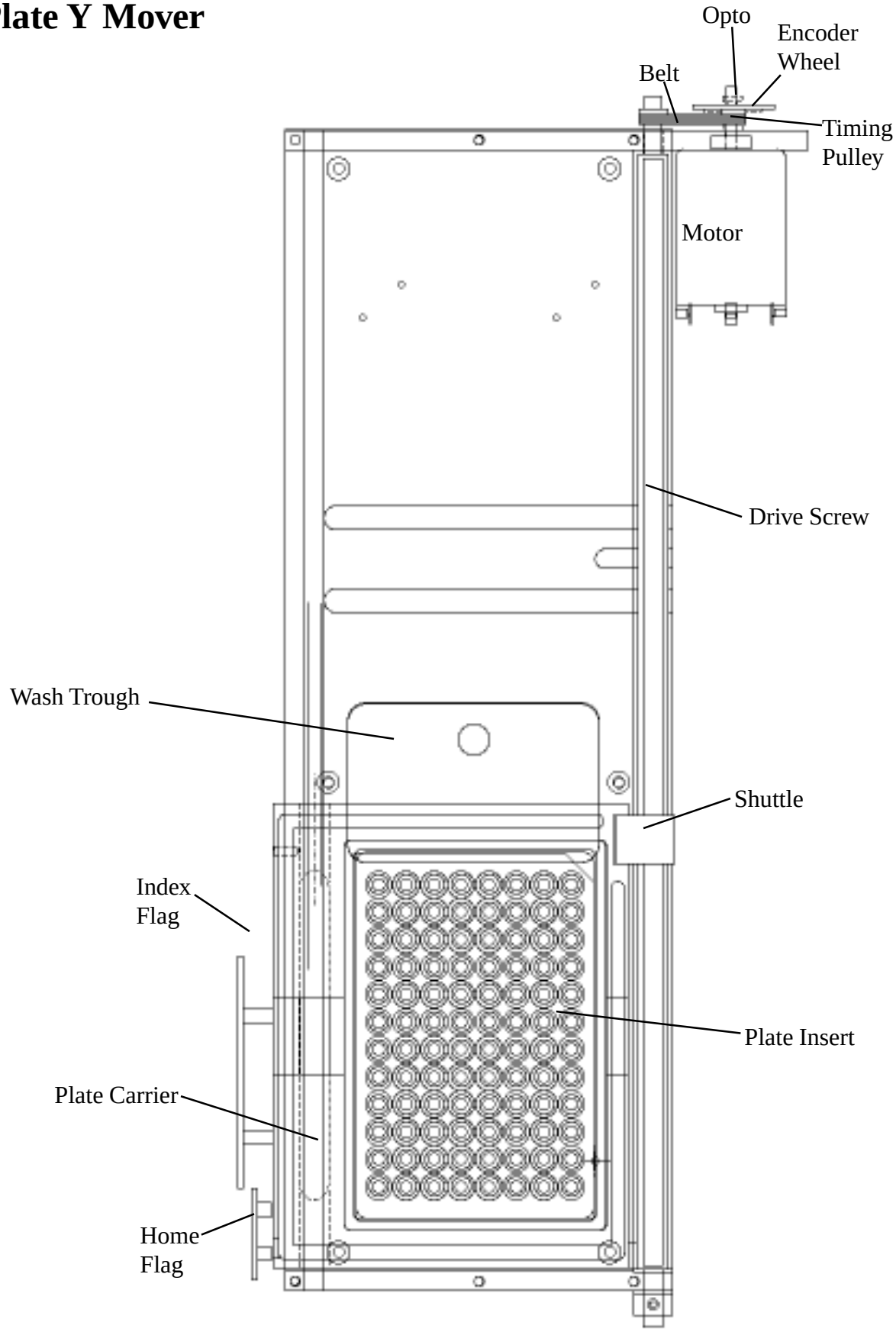

Figure #1.3.6

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Rack Y Mover

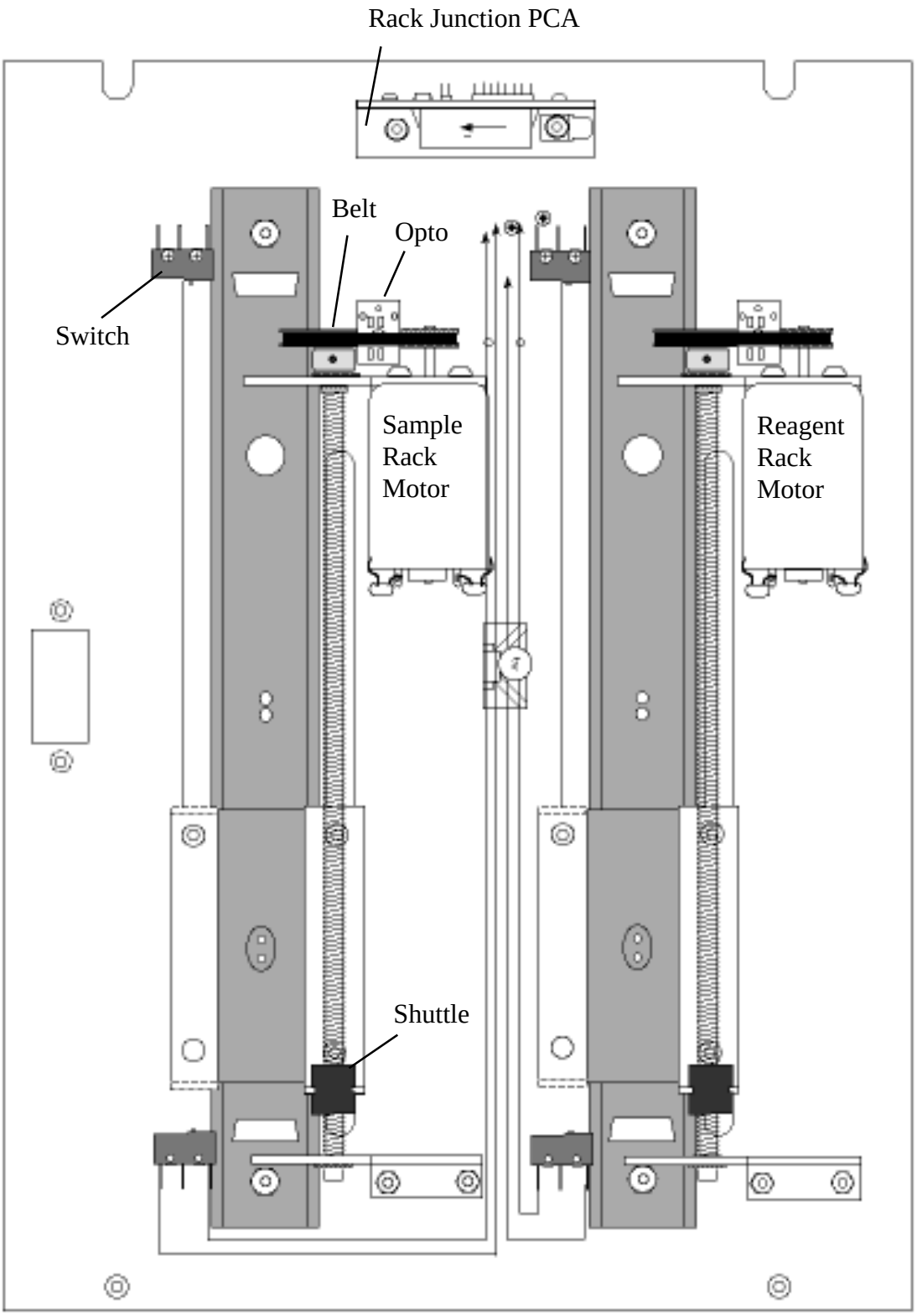

Figure #1.3.7

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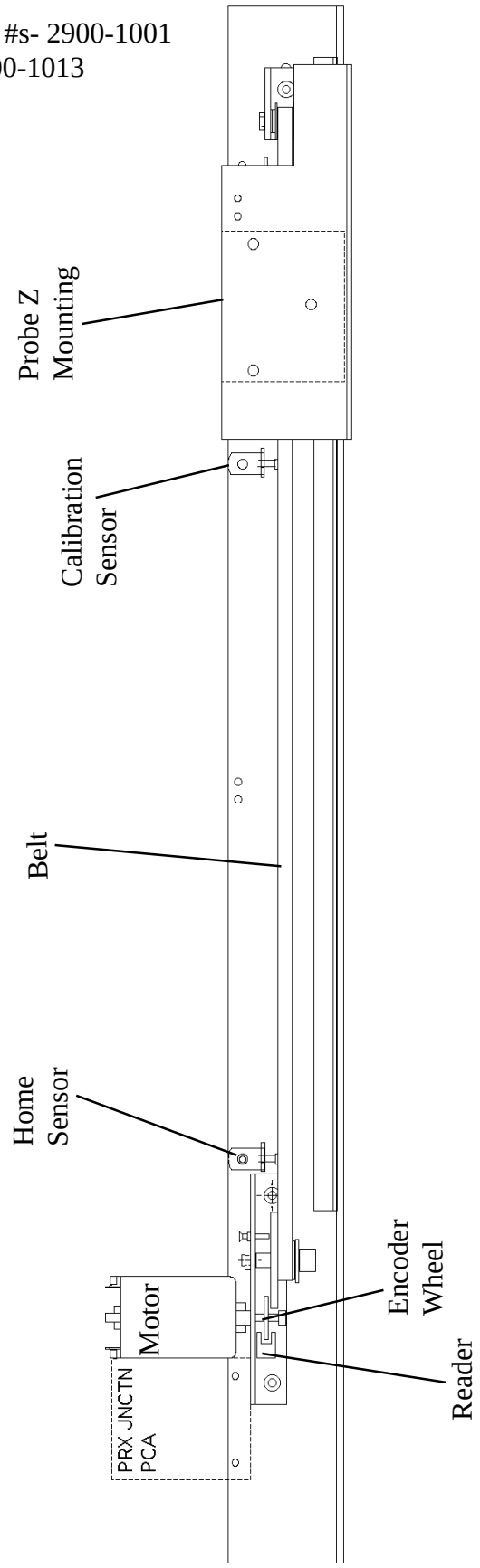
Probe X Mover

Serial #s- 2900-1001 to 2900-1013



Serial #s- 2900-1014 to current

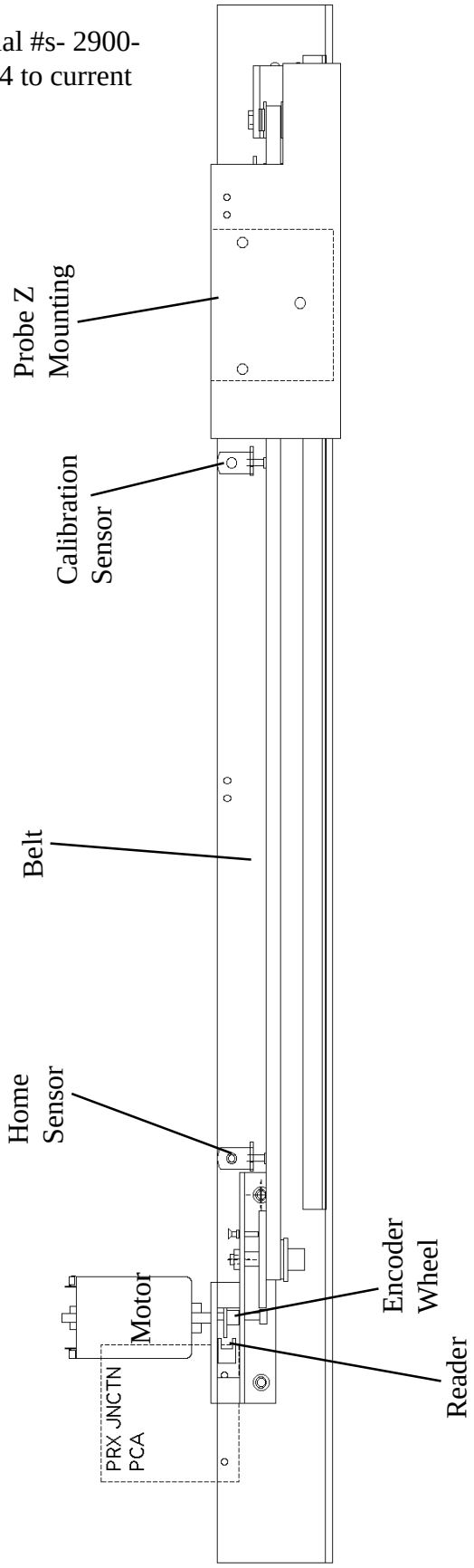


Figure #1.3.8

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Probe Z Mover

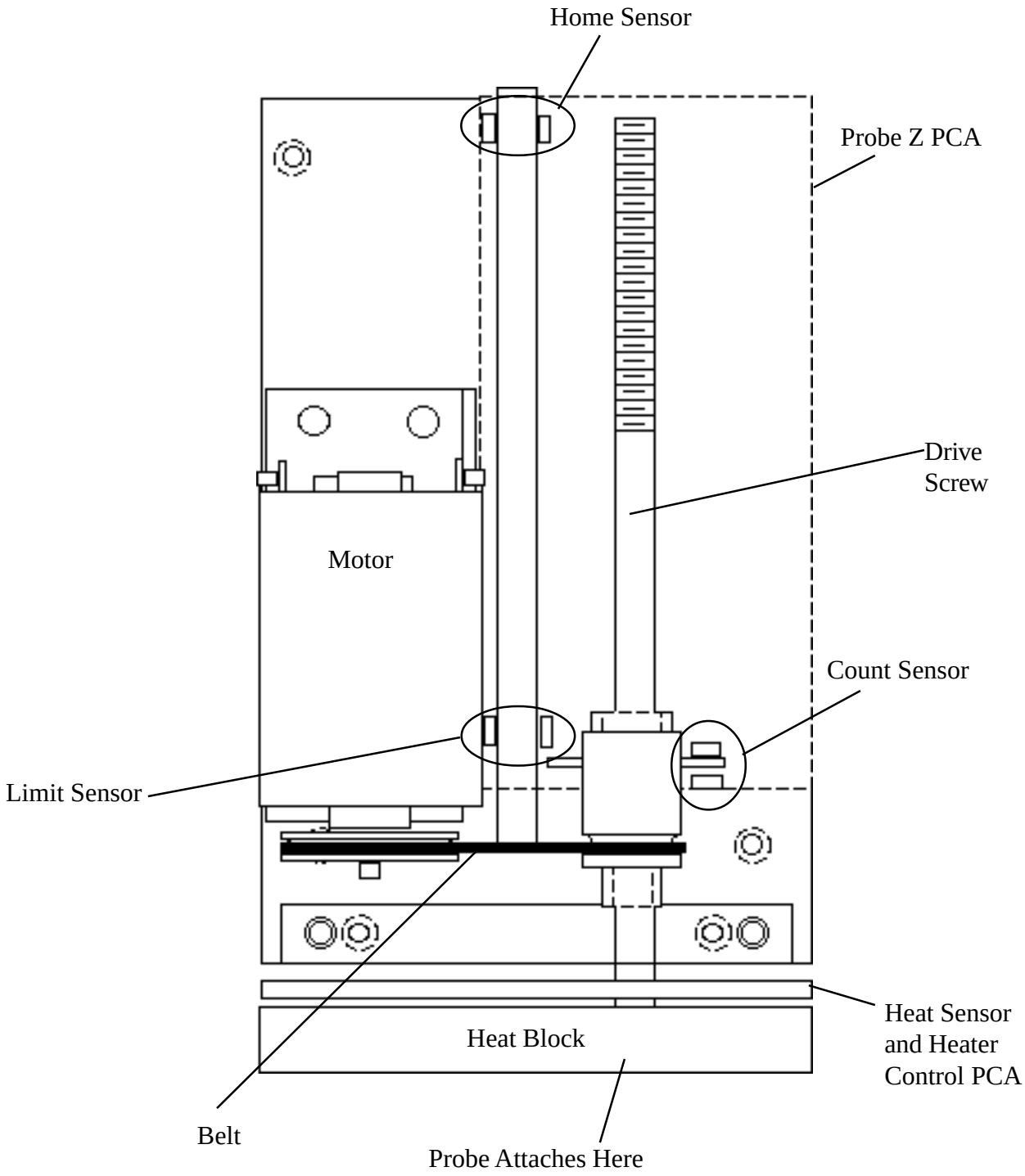

Figure #1.3.9

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Washer

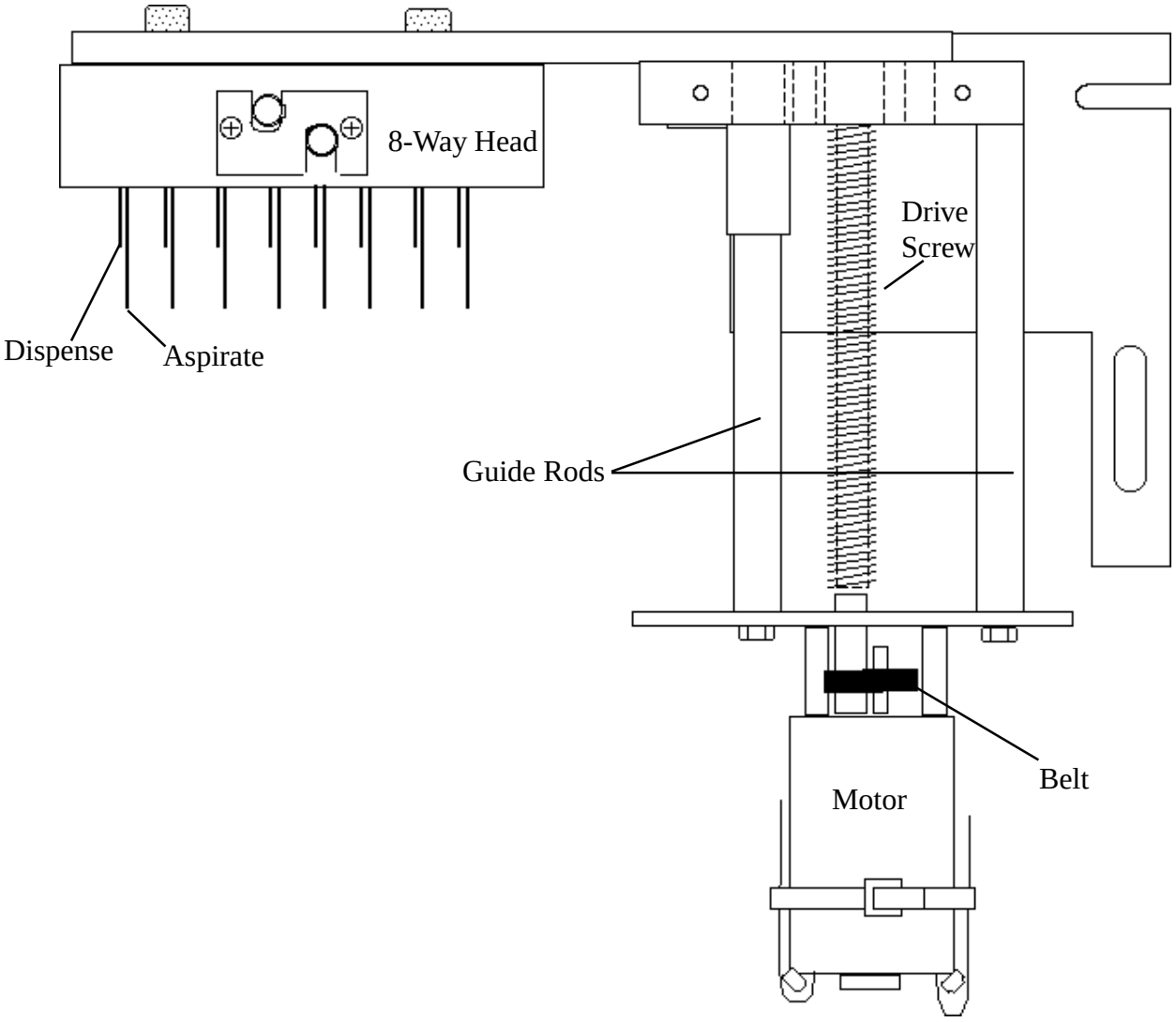

Figure #1.3.10

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Electronics Rack

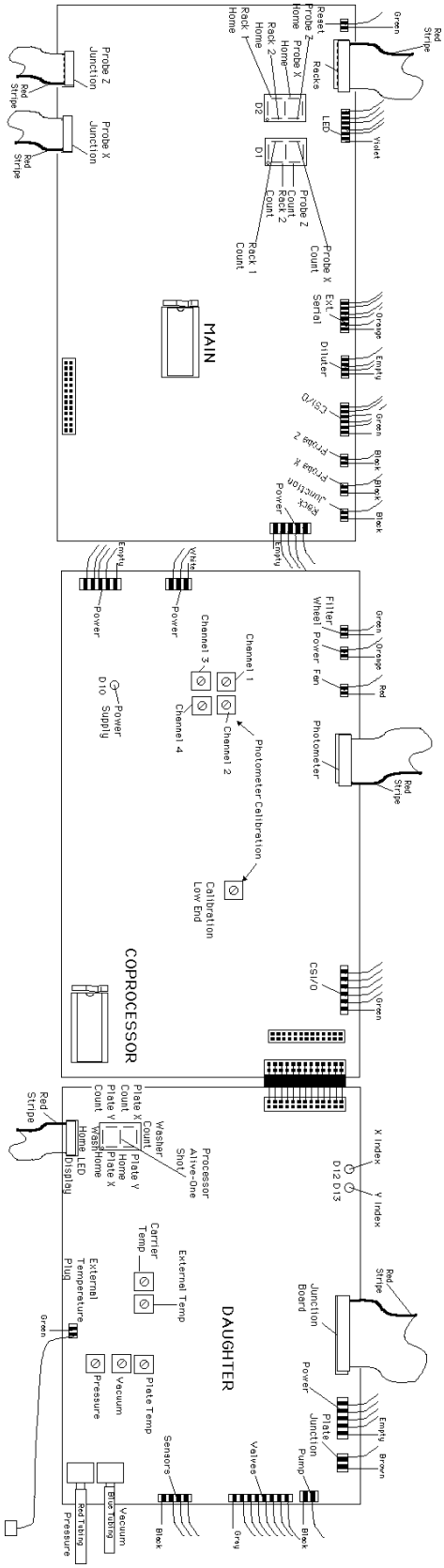

Figure #1.3.11

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Bottle Connections, Pump, and Valve Bracket

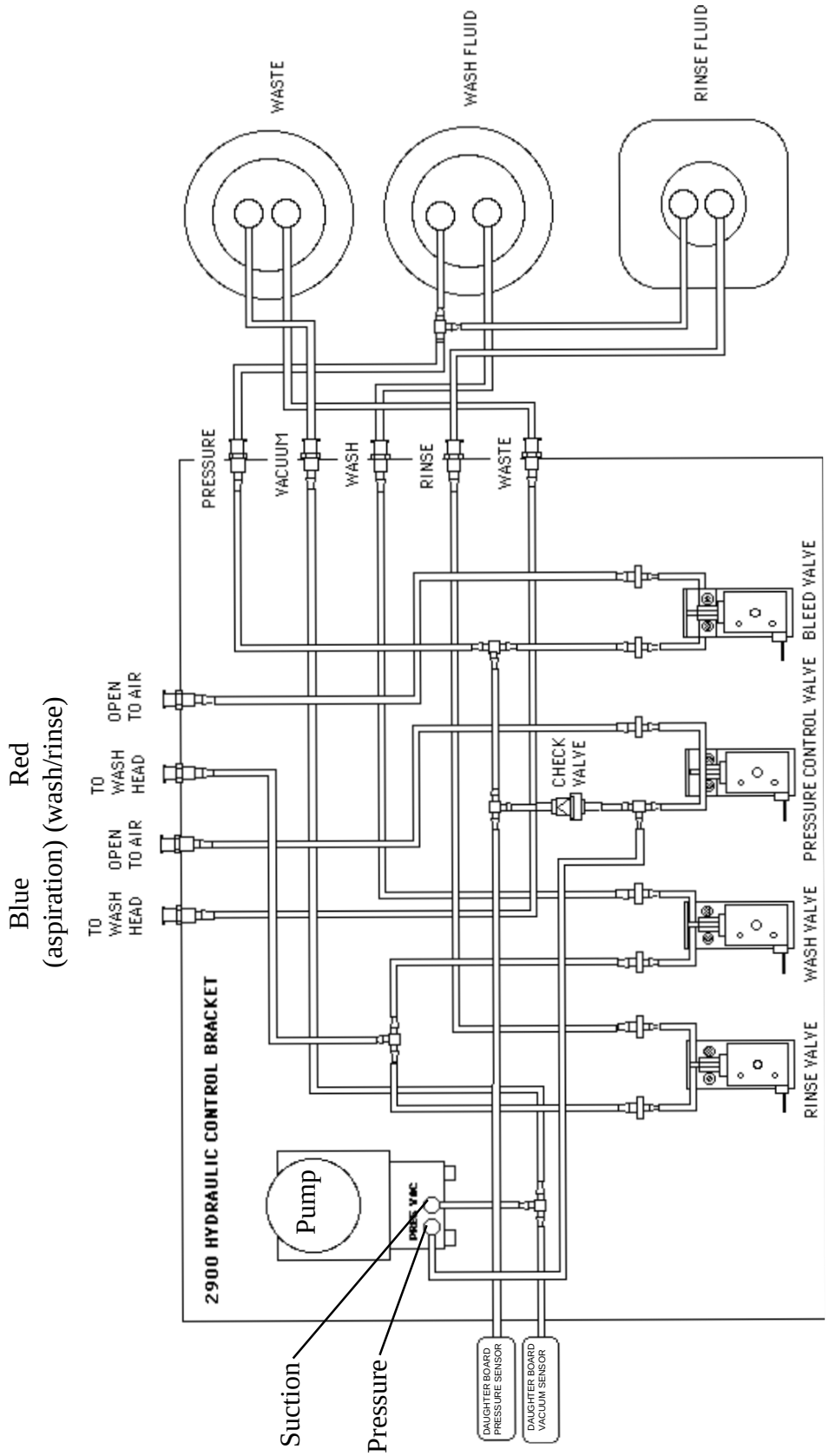

Figure #1.3.12

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Syringe Pump

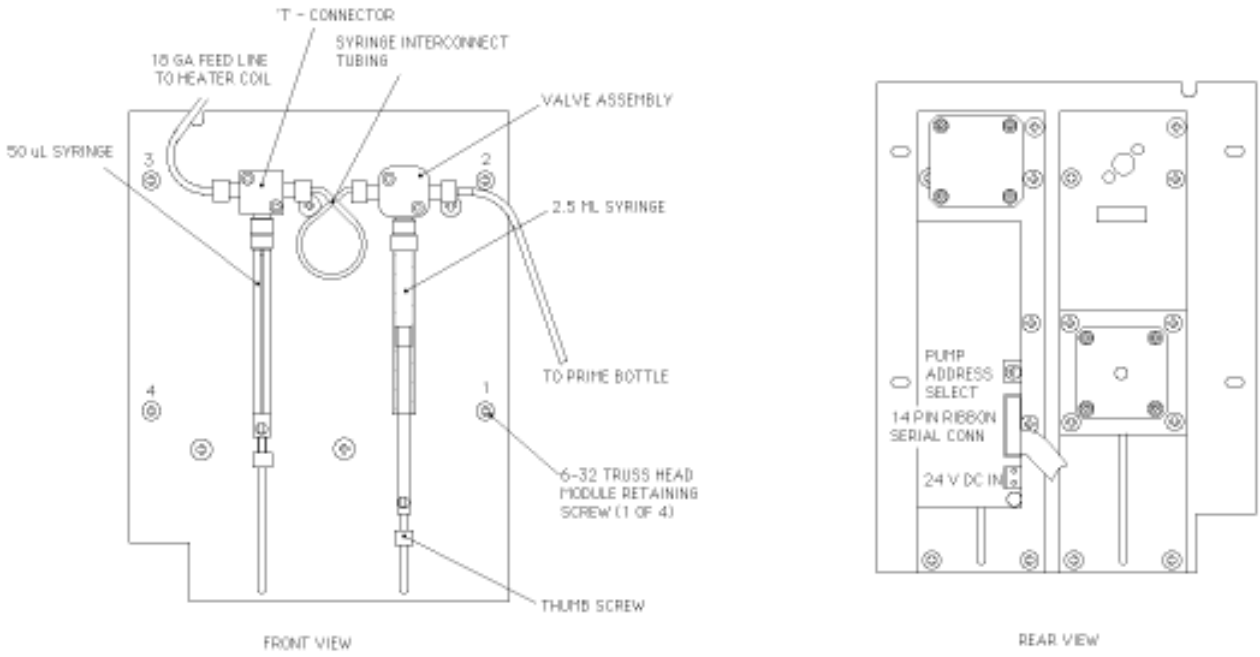

Figure #1.3.13

Photometer

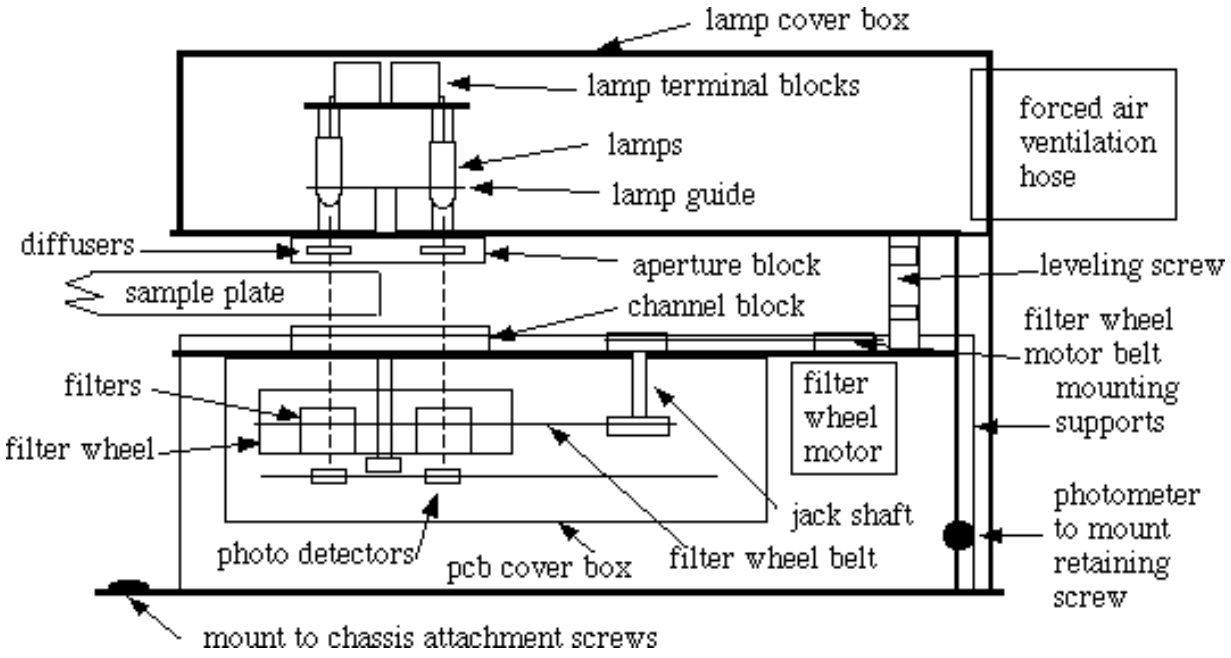

Figure #1.3.14

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Bottle Set

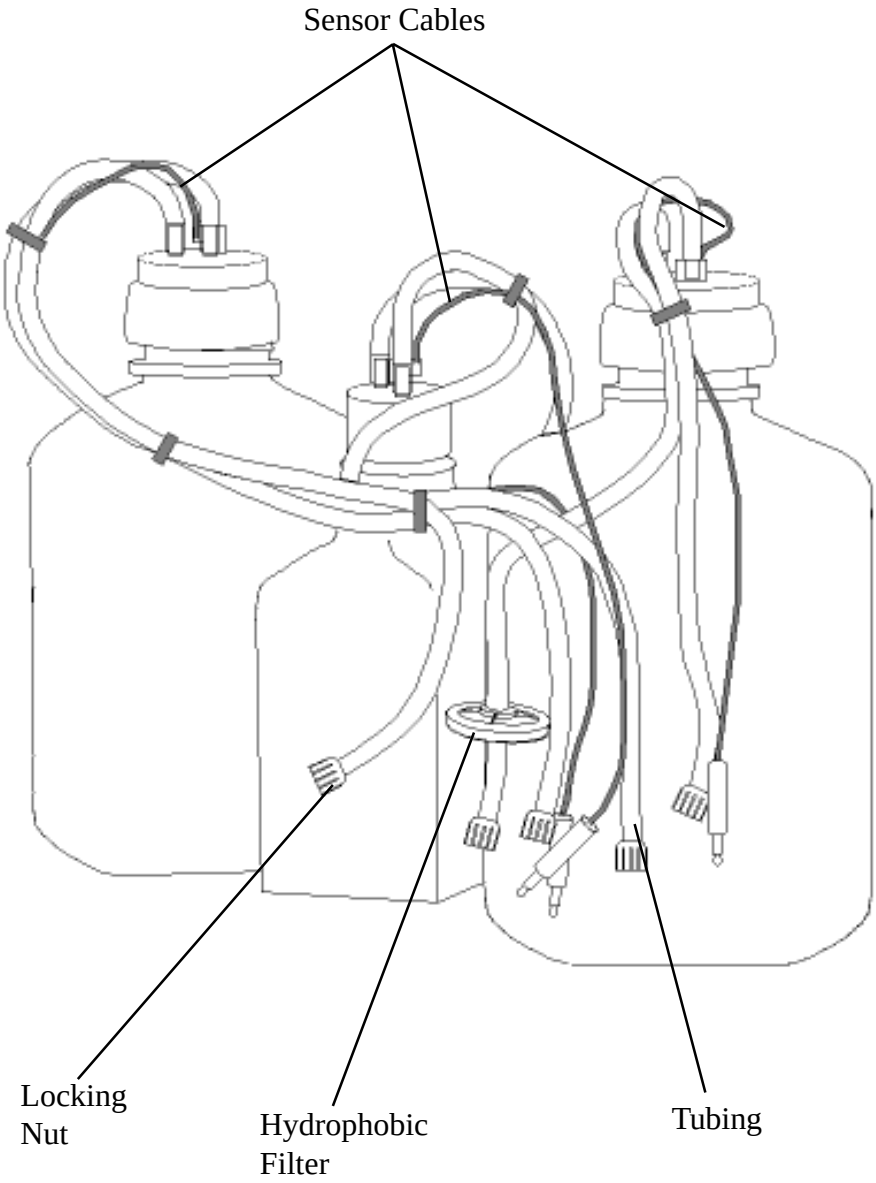

Figure #1.3.15

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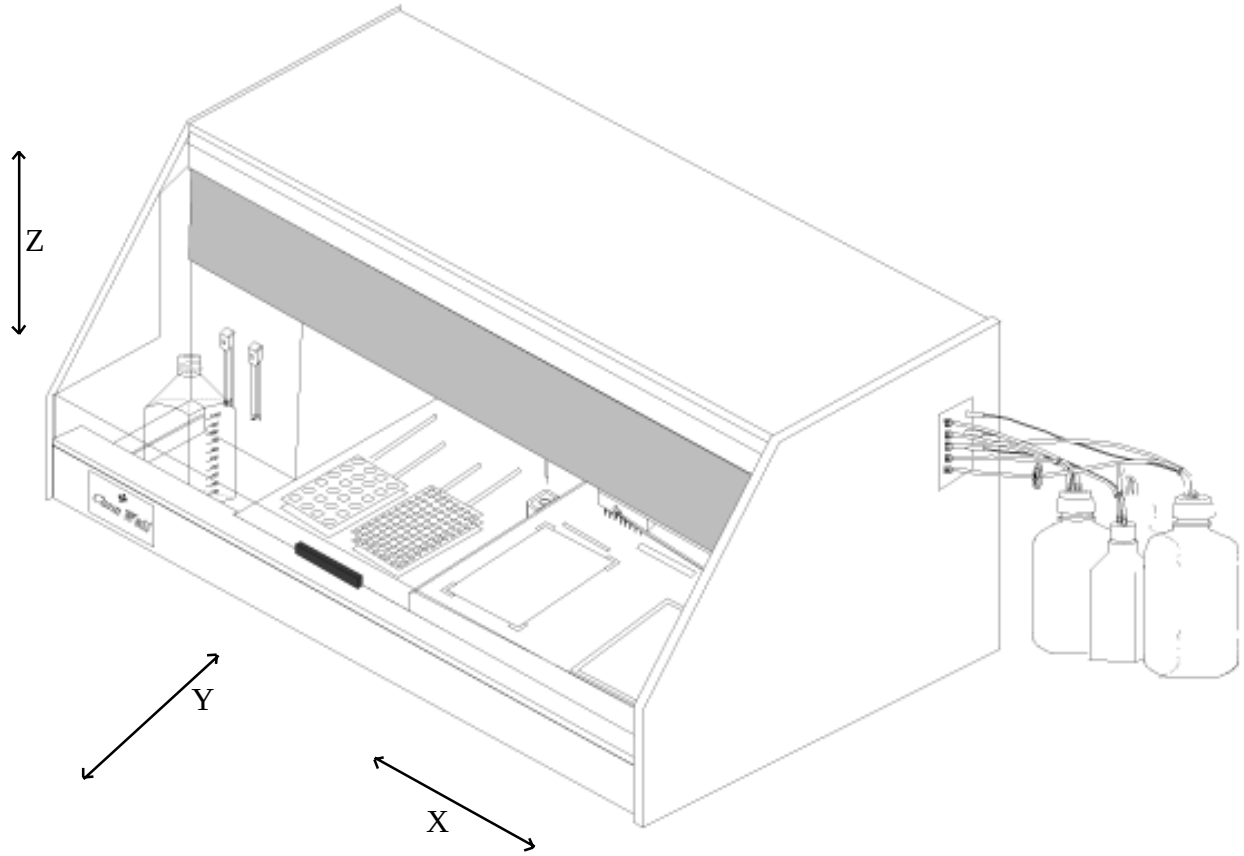
ChemWell Coordinate System



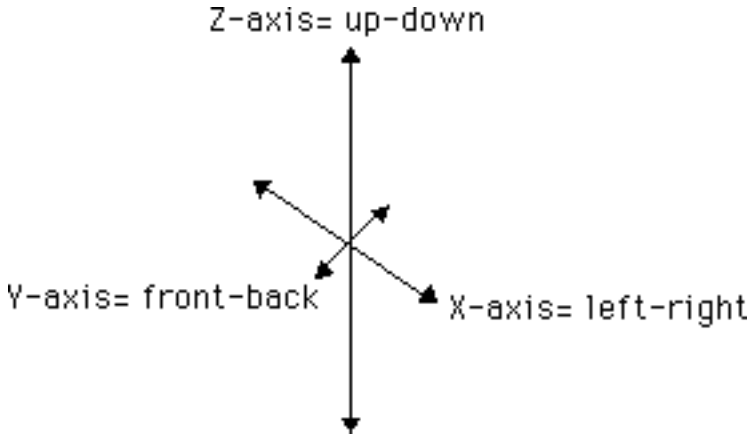


Figure #1.3.16

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1.4 Technical Specifications

Overall

Typical throughput	up to 200 endpoint reactions per hour or 170 kinetic reactions per hour
Typical reaction volume	200 uL or less
Dimensions	86cm W X 51cm D X 40cm H, approx. weight = 45kg

Reagent and Sample Dispensing

Capabilities	dilutions, predilutions, dispensing single or multiple reagents
Pumps	Two syringe pumps, sized: 50 uL and 2.5 mL
Probe	316 stainless for maximum reagent compatibility, level sensing
Min. and max. volume	2 uL - 2.5 mL
Precision	<1%
Maximum number of specimens (including calibrators and controls)	96
Maximum number of reagents	40 (assorted replaceable racks and custom designed racks are available for various bottle sizes.)
Reaction vessel	standard microwells, strips or plates
Instrument bottles:	2L wash with low volume warning sensor 1L rinse (or Wash #2) with low volume warning sensor 2L waste with full warning sensor 1L priming bottle

Incubating, timing and temperature control

EIA mode	incubation of each row of 8 is timed separately
Chemistry mode	each group of 4 wells is timed separately
Thermal control	plate/well 25°C, 37°C, or ambient; probe/coil 37°C or ambient

Washing

Wash head	8-probe, automatic prime and rinse
Programs	create and run user programmable protocols (aspirate, dispense, soak) can wash wells for reuse as applicable

Reading

Optical design	reads absorbance in 4 simultaneous channels, NIST traceable calibration, user selects monochromatic or bichromatic results 8 position
Light Source	Xenon lamp
Filter Wheel	340, 405, 450, 505, 545, 600, 630, 700 or custom
Interference filters	long life, hard coat, ion assisted deposition, +/- 2nm, 10nm typical half bandpass
Linear range	-0.2 to 3.0A
Photometric Accuracy	+/- (1% of the reading +0.005A from 0 to 1.5A) +/- (2% of the reading +0.005A from 1.5 to 3.0A)

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Software

Format	1.44MB, 3-1/2" disks
Operating Systems	Windows® 95/98, Windows NT® 4.0, or Microsoft® Windows® 2000 Professional, Beta 3
Min. system	486/66, 8MB RAM, 20MB free HD space, VGA monitor, serial port, Windows® 95/98 or Windows NT® 4.0
Recommended system	Pentium™, 16MB, 20MB free HD, SVGA graphics and moni tor, serial port, Windows® 95/98 or Windows NT® 4.0
Main menu options	Patients, Quick Job, Job, Setup
Secondary menu options	create/edit protocols, import/export assays, data, etc., Control, Run, Setup
Calculation modes	absorbance, single standard, factor, fixed time kinetics, kinetics by standard or factor, multi-calibrator point-to-point, linear regressions, log-logit, absorbance cutoff, and more
Self monitoring modes	lamp, bottle volumes, filters, pressure, vacuum, mechanical function, and more
QC options	store control data, print Levey-Jennings or QC range plots, calculate SDs

Power:

Voltage Range	100-250VAC
Frequency Range	50-60Hz
Power Maximum	160W
Installation Category	CAT II

Enviromental Conditions for Safe Operation:
Indoor Use
Altitude up to 2000m
Temperature 5°C to 40°C[1]
Humidity 80% for temperatures up to 31°C decreasing linearly to 50% humidity at 40°C.
Mains supply fluctuations not to exceed +/-10% of the nominal voltage.

Recommended Enviromental Conditions:

Recommended Operating Temperature:	18-35°C
Recommended Operating Humidity:	less than 85%

CE Marked

[1] Although it may be safe to operate in these conditions, it may not be suitable for the performance of your tests. Check with your supplier.

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2.0 Principles of Operation

2.1 System Control / Electronics Rack

ChemWell has three large printed circuit boards which regulate and control the system. All three boards are mounted to the top of the electronics rack, easily accessed by lifting the top cover of the instrument. On the underside of the electronics rack (visible only after the back cover of the instrument has been removed) are the two switching power supplies and associated junction boards. See Figures #1.3.11 Electronics Rack, 2.2 Main PCB Connections, 2.3 Coprocessor PCB Connections, 2.4 Daughter PCB Connections, 2.5.8 DC Junction PCB Connections, and 2.7 Back of Electronics Rack.

The board on the far left as you face the front of the instrument is “Main” (2900-100). This board contains one of the two Z180 microprocessors. The other microprocessor can be found on the “Coprocessor” (2900-200) board, which is the middle of the three boards. The Coprocessor board has a direct bus interface to the board on the right, known as the “Daughter” (2900-300). The functions and communications between these boards are described in the sections that follow.

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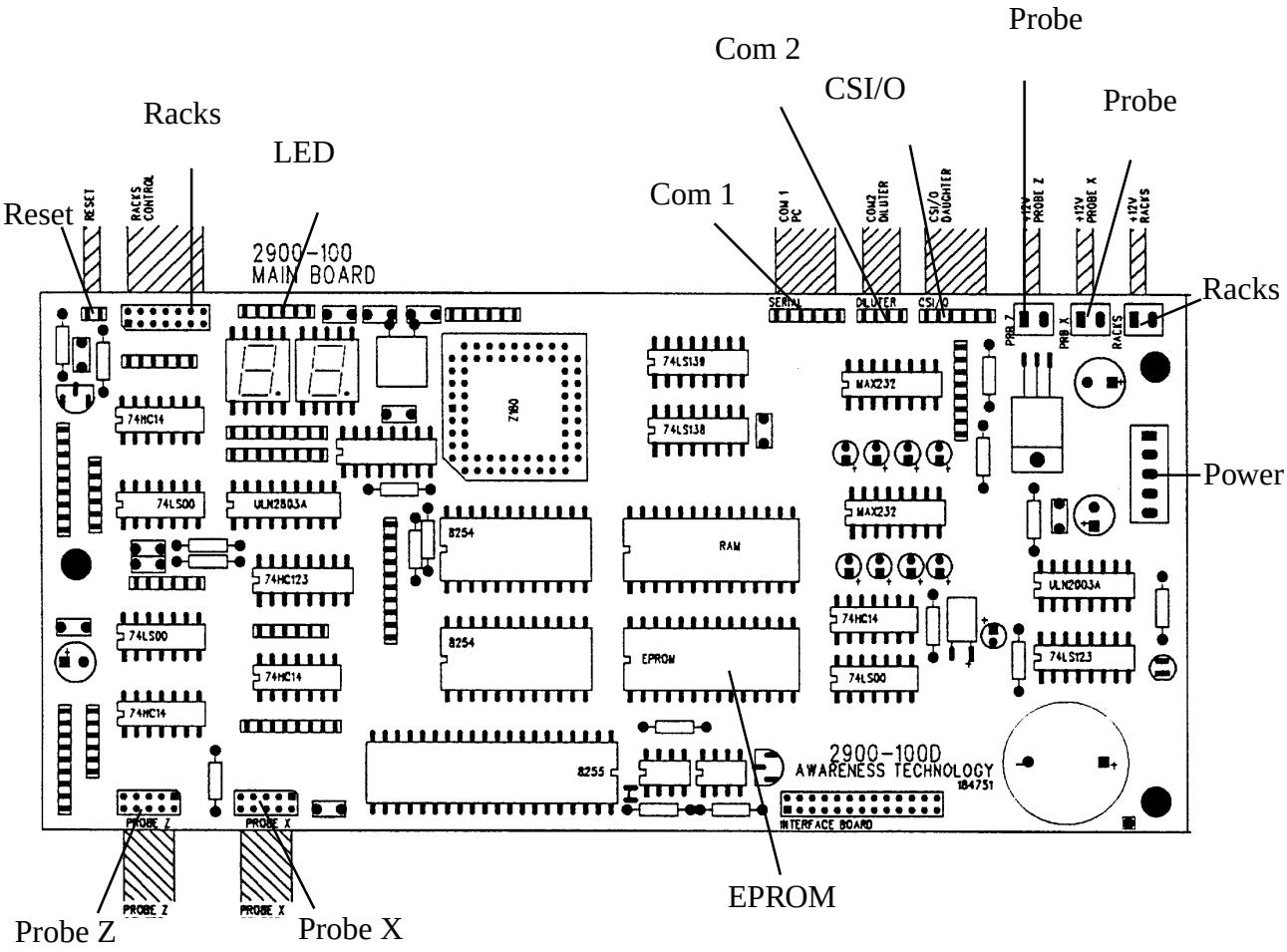
2.2 What Main Controls

→ External interface to computer (RS-232 Serial Interface)
→ Interface to syringe pumps (RS-232 Serial Interface)
→ Position Detection and control of:
- Probe Z
- Probe X
- Rack 1
- Rack 2

→ Probe / Coil Heating
→ Probe level Sensing
→ CSI/O interface to Coprocessor



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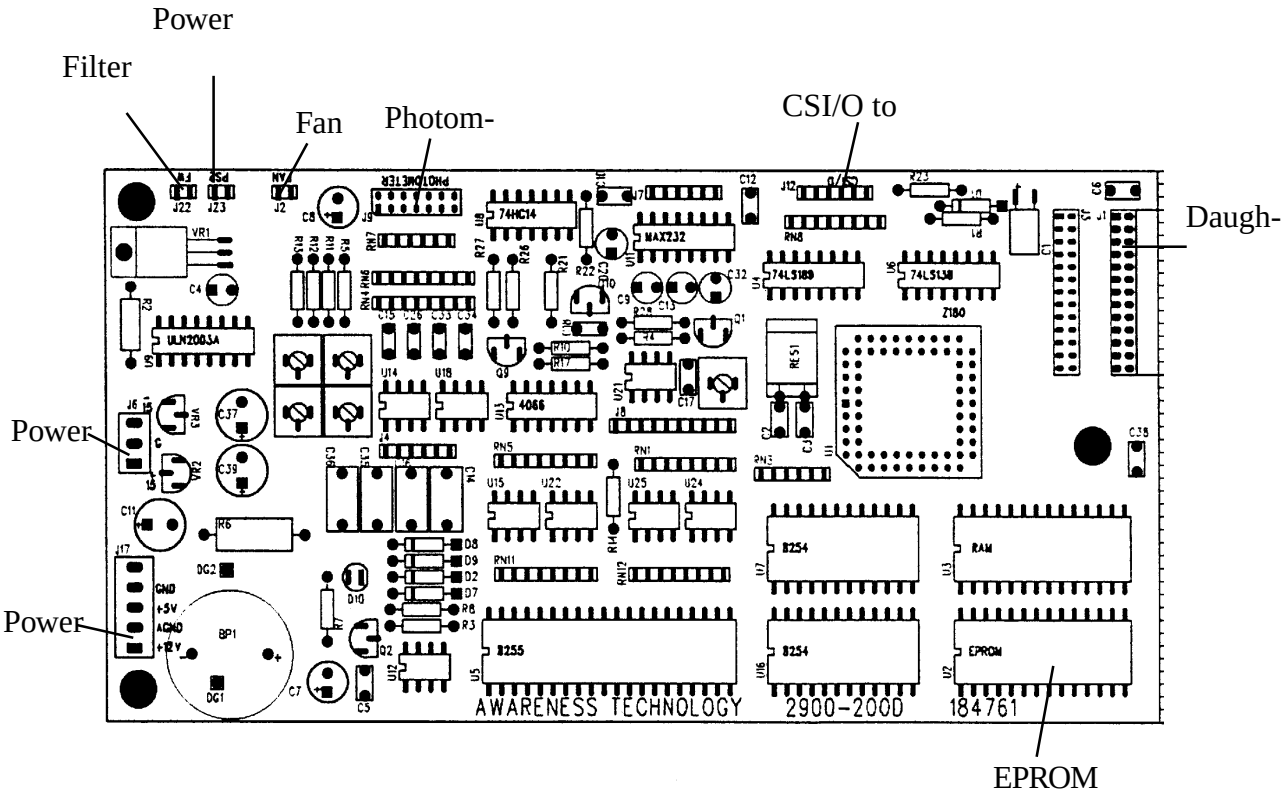
2.3 What Coprocessor Controls

→ Photometer
→ Filter wheel
→ Lamps (via control of power supply 2)
→ Bus interface to daughter board
→ Power Supply #2



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2.4 What Daughter Controls

→ Position Detection and control of:
- Wash head
- Plate X
- Plate Y

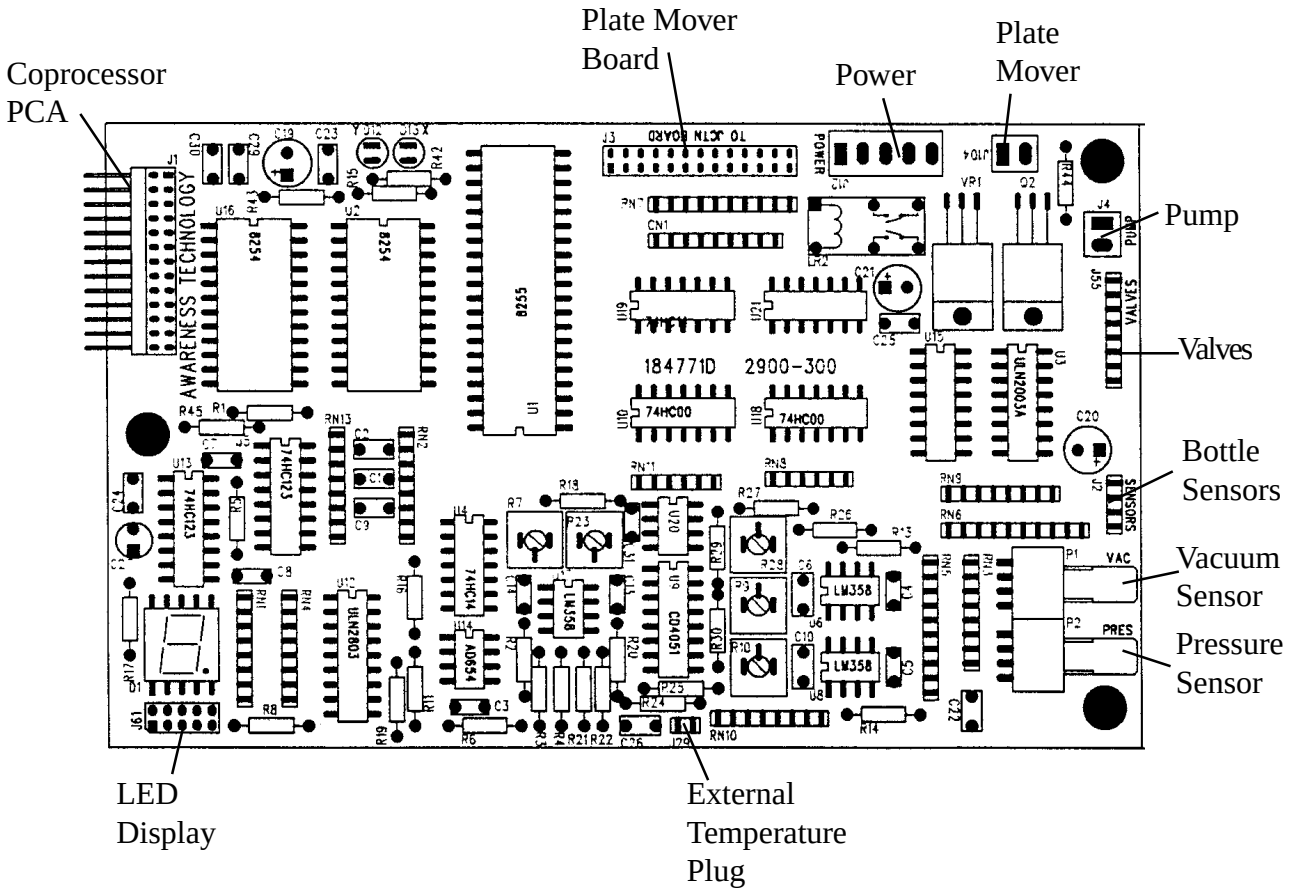
→ Plate Mixer

→ Plate Heater, Temperature Sensor, External Temperature Sensor

→ Pressure / Vacuum control
- Pump
- Pressure and Vacuum Sensors

→ Valves
- Rinse
- Wash
- Bleed
- Pressure Ctrl

→ Bottle Liquid Level Sensors



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2.5 All Junction Boards

This section describes these additional boards, their dedicated roles, and their locations.

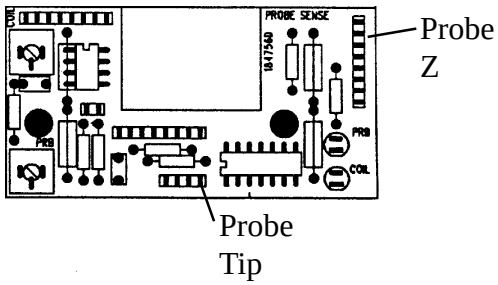

Figure #2.5.1 Probe Sensor/ Heater Control PCB Connections

The Probe Sensor and Heater Control PCB controls the fluid sensing and heat control for the coil block and probe. This board mounts to the top of the coil block

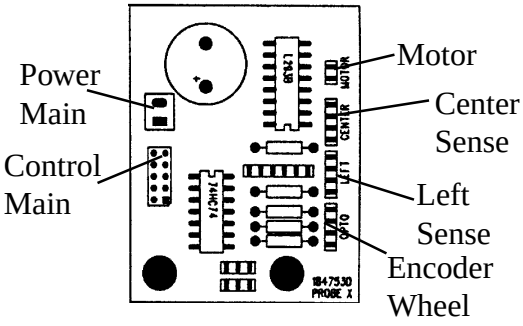

Figure #2.5.2 Probe X PCB Connections

The probe X board controls the sideways movement of the probe. This board is mounted on the left side of the probe X bracket under the electronics rack.

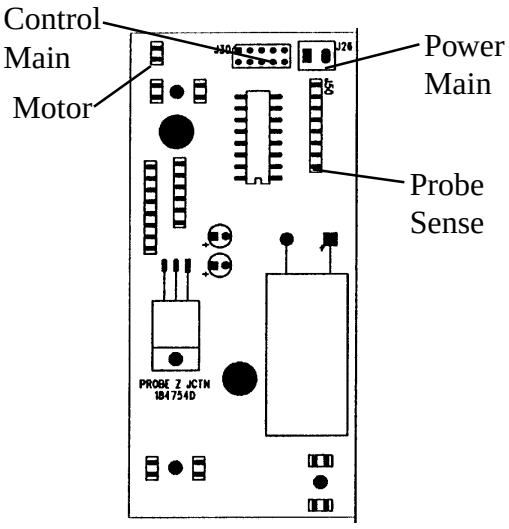

Figure #2.5.3 Probe Z PCB Connections

The Probe Z board controls the up-down motion of the probe. This board interfaces with the Probe Sense and Heater Control board located inside the probe housing.

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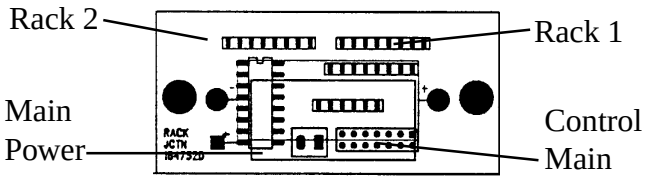

Figure #2.5.4 Rack Y PCB Connections

The Rack Y Mover coordinates the motion of Rack 1 (reagent rack) and Rack 2 (sample rack). It is located on the rear of the Rack Mover Assembly.

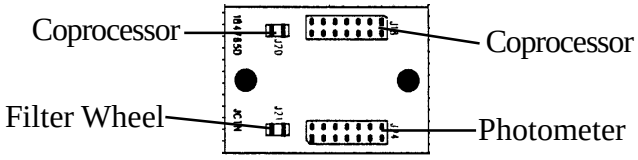

Figure #2.5.5 Photometer Junction PCB Connections

The Photometer Junction board is the junction point for the Photometer mechanism. The board is located on the Photometer Module.

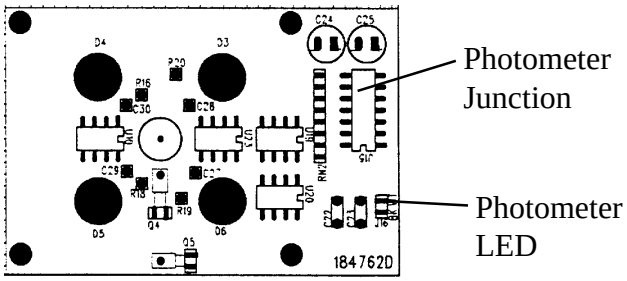

Figure #2.5.6 Photometer PCB Connections

The Photometer PCB optically reads the light emitted by the lamp after passing through the plate. It is located inside the Photometer housing.

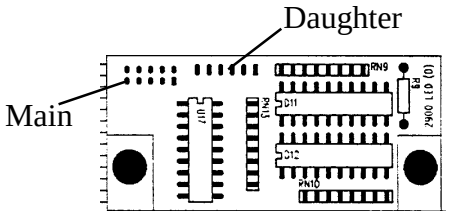

Figure #2.5.7 LED Display PCB Connections

The LED Display shows the status of various states of the mechanisms. See troubleshooting for a full outline of what each light means. The board is located behind the Probe Shield.

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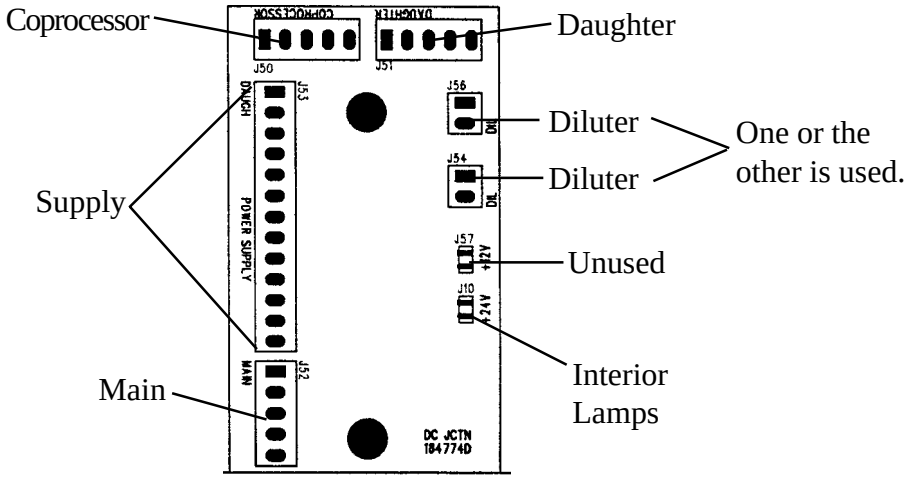

Figure #2.4.8 DC Junction PCB Connections

The DC Junction board is the distribution center for DC power for the instrument. It is located under the electronics rack.

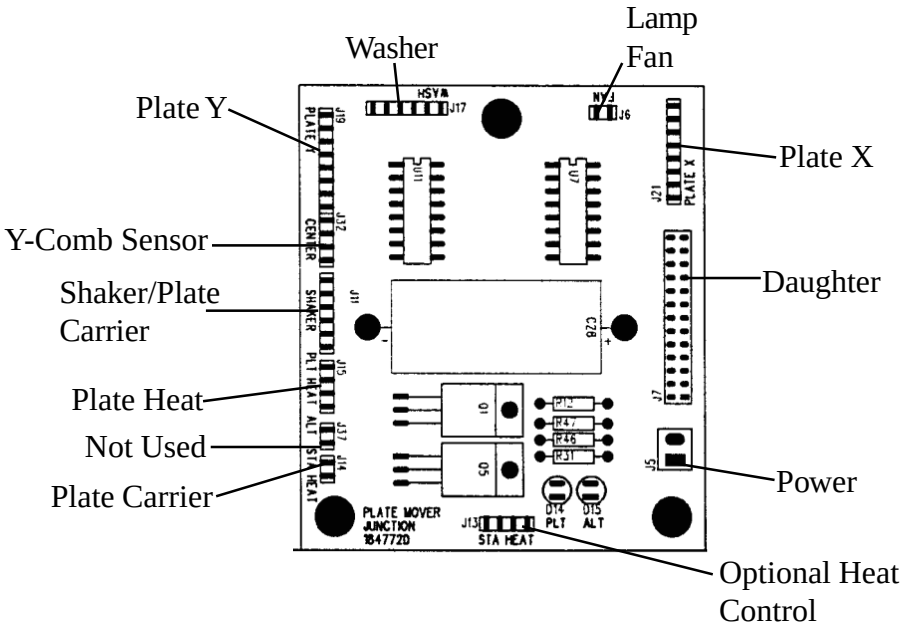

Figure #2.5.9 Plate Mover PCB Connections

The Plate Mover coordinates the Plate X-axis, Plate Y axis movements, the Plate Carrier incubation, mixing, fan, and wash movements. It is located to the right and under the Plate Cover. Note: Plate Carrier connection is currently not used. The extra two-position connector with two orange wires should not be plugged into the board.

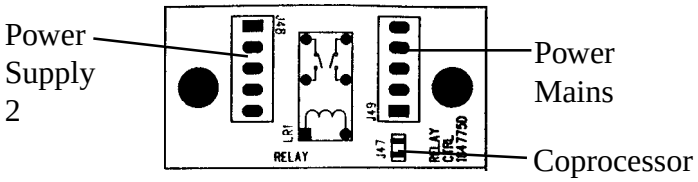

Figure #2.5.10 Relay PCB Connections

The Relay board turns the second power supply off. It is mounted inside the electronics rack.

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2.6 Main and Coprocessor, How They Communicate

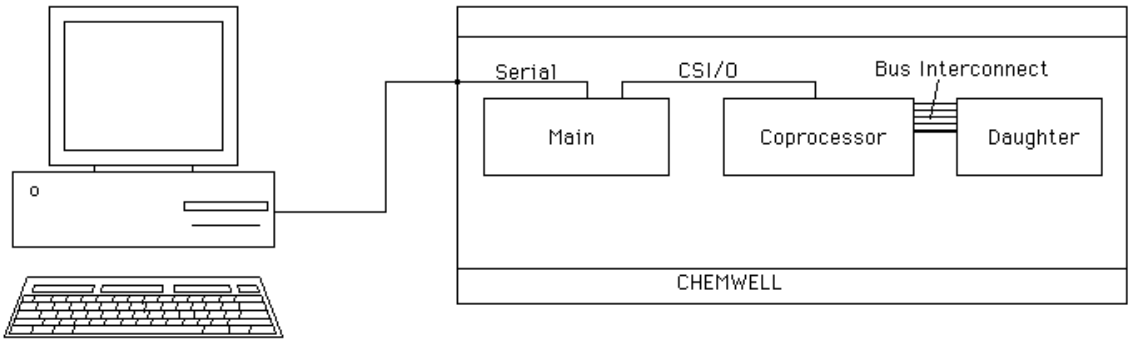

Figure #2.6 Computer to ChemWell Communication

The cable from J8 of the Main board (2900-100) to J12 of the Coprocessor board (2900-200) interconnects the two processors and allows them to communicate. This connection uses a version of the Z180's CSI/O (Clocked Serial I/O). When a command is received from the PC by Main, the firmware on the Main board will determine if the command must be executed by the Coprocessor. This is the case, for example, when sending a command such as !WPRI, Wash Prime. Since both the wash head and the pressure system are controlled by the Coprocessor, it is responsible for executing this command. Using the CSI/O connection, Main will forward this command to the Coprocessor and wait for it to be completed. When the command is complete, the message will be sent from the Coprocessor to the Main board via the CSI/O connection and then echoed by Main back to the PC using the serial port.

In addition to the commands originating from the PC, Main and Coprocessor communicate to coordinate a variety of functions. This communication is transparent and the ChemWell can be treated as a unified instrument. The only time when it may become necessary for the service technician to examine the CSI/O connection is if the processors are unable to communicate at startup. How to diagnose and solve this problem is covered in the troubleshooting section.

The Coprocessor board and the Daughter board should be considered one unit. The Z180 microprocessor on the Coprocessor board directly controls the peripherals on the Daughter board by means of the bus interconnect. The 26-pin right-angle connectors directly tie together the data and address buses of the two boards.

2.6.1 Firmware versus Software

The internal software, usually referred to as the firmware, is responsible for the direct control of the mechanisms and other systems. The firmware is actually divided into two parts; one for each of the two Z180 processors inside ChemWell. The communication between the processors is described above. The firmware is programmed into two EPROMs (UV-Erasable Programmable Read Only Memory) and installed on the two microprocessor boards. The firmware "Main" is for the Main board (2900-100) and "Cop" for the Coprocessor (2900-200). The firmware revision will be printed on the EPROM labels.

The "software" refers to the Windows program running on the external PC. This is the program that interacts with the user and controls the ChemWell. Fundamentally this software breaks down all opera-

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tions into a set of commands which the instrument can execute. For an explanation of these commands see Troubleshooting- Tools. The version of the software can be identified by selecting “Help/About...” from the ChemWell pull-down menu. In this dialog you will see a message in the format “Version x.xx / Build yyy”. The Build Number is the primary means of identifying the software version. **Also, see section 3.1.3 Reports.**

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2.7 Power Supply

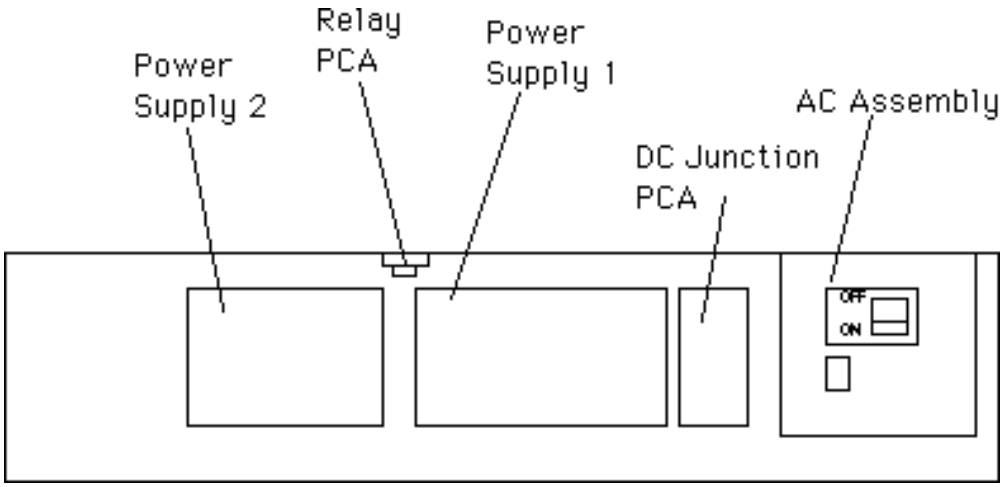

Figure #2.7 Back of Electronics Rack

See also: System Overview Diagram in Appendix B

ChemWell uses two switching power supplies, both of which are mounted in the lower portion of the electronics rack. The power supplies should require no maintenance or adjustment in the course of normal operation. To access the power supplies, unplug the instrument and remove the four screws which attach the back cover of the instrument.

WARNING: The power supplies contain high voltage and can cause injury. Do not operate the instrument with the back cover removed.

Facing the back of the instrument, you will see a small box at the right side containing the power receptacle and the main power switch. (Note that ChemWell has no voltage select switch as the power supplies are autoswitching.) Inside this box are the main fuses for the instrument. See “Fuse Replacement” for more information. Two sets of AC lines originate from inside this box. One set goes directly to the first power supply and the other goes to the relay board. The first power supply converts AC power to provide DC +12V, +5V, and +24V to the instrument. It is always operating when the instrument is turned on.

The DC output from the first power supply connects to the adjacent DC Junction Board using a 13-wire header. This board distributes the DC voltage and has connections for the Main, Coprocessor, Daughter boards as well as the syringe pumps and internal lamps. See Appendices for the layout. Only one of J56 or J54 will be connected to the pumps and J10 (+24VDC) powers the internal lamps. The three connectors J50, J51, and J52 provide +12VDC, +5VDC, and two grounds to each of the three main boards. The +5V supply should be between +4.9V and +5.25V and the +12V supply between +11.5V and +12.25V depending on the current load.

The second power supply is turned on and off via the relay junction board, which controls the AC input power using a 12VDC relay. The relay is controlled by a ULN2003A (U9C) driver on the Coprocessor board. This second supply provides the lamp and photometer operating voltage. The lamps are wired

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directly to this supply to minimize voltage variation. Lamp supply voltage is approximately +6VDC. This supply also produces +/- 14-15VDC which is routed to the Coprocessor board at J6. Components VR2, VR3, C37, and C39 regulate these voltages to +/- 12VDC which are used to operate the photometer circuits. See “Principles of Operation of the Photometer” for more information.

2.8 Watchdog Circuit

All valves, motors and pumps are powered through the major boards. The Main board provides +12 volts through an IRF9530A MOSFET Q1A, which is in turn driven by the re-triggerable one-shot comprised of C14, R5, and U12A. The microprocessor re-triggers U16A at intervals smaller than the one-shot period. If the microprocessor system “crashes” or otherwise malfunctions, U12A will time out and shut down the motors (rack and probe) and coil heating power by turning off Q1A. If this occurs, LED D3 will be turned off to provide a visual indication.

The Daughter board provides +12V to its systems through a Relay LR2, which is in turn driven by the re-triggerable one-shot comprised of C27, R17, and U13A. The microprocessor re-triggers U13A at intervals smaller than the one-shot period. If the microprocessor system “crashes” or otherwise malfunctions, U13A will time out and shut down the valves and pumps by turning off Relay LR2. If this occurs, the middle bar of a seven segment LED on the Daughter board will be turned off to provide a visual indication on the Daughter board.

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2.9 Motion Control

Also, refer to section 3.5 Motor Control for general information on motion sensing.Racks:
Two bidirectional DC motors, under microprocessor control, turn 3/8-16 machined stainless steel lead screws via neoprene belts and nylon pulleys. One motor is dedicated to Y motion of the rack 1 (reagent), the other to the Y motion of the rack 2 (sample). Attached to the lead screw is an encoder wheel which has ten holes that create pulses when passing between an IR LED and a phototransistor creating tachometer pulses provided to microprocessor. These tachometer pulses are provided to the microprocessor at the CLK1 input and CLK2 input at 8254 U5. Microswitches positioned at extremes of rack movements disable the motor drivers U22 via NAND gates U18 when the travel limits are reached. Two switches additionally indicate the home positions to the microprocessor. LEDs D1 and D2 provide visual feedback to the service technician of the tach pulses and home positions. The Rack Junction PCB holds the motor drivers. The index pulse buffers, and limit logic, are on the Main PCB. The rack junction connects to Main via 10 pin ribbon cable and two wire power cable.

Plate:
Two bidirectional DC motors, under microprocessor control, turn 3/8-16 machined stainless steel lead screws via a 55 tooth 40 DP timing belt and two 27 tooth 40 DP timing pulleys. One motor is dedicated to X motion of the plate carrier, the other to the Y motion of the plate carrier. Each drive pulley attached to the motor has an encoder wheel with ten holes which create pulses when passing between an IR LED and a phototransistor, providing tachometer pulses to the microprocessor at the CLK1 input and CLK2 input at 8254 U16. Phototransistors, positioned at extremes of the plate carrier movements, disable the motor drivers U7 and U11 via NAND gates U10 and U18 when the travel limits are reached. Two of these phototransistors additionally indicate the home positions to the microprocessor. LED D1 on the Daughter board provides visual feedback to the service technician of the tach pulses and home positions. The plate mover junction PCB holds the motor drivers. The Daughter PCB holds the index pulse buffers, limit logic, and connects to the main PCB via a 26-pin ribbon cable and power. Additionally, phototransistors generate X and Y axis index pulses to position the plate carrier with regard to the photometer.

Mixer (Shaker):
Mixing in wells is accomplished by shaking the Plate Carrier Y-axis platform. The platform is supported by 4 flexible natural latex rubber mountings and is attached to the underside of the platform (a motor driven counterweight). Spinning the counterweight causes the platform to shake on its mountings with proportional intensity. Microprocessor control of the shaker motor via U7 on the coprocessor PCB allows for adjusting the single mix/shake intensity setting. Adjust the mixing using Telix command, !MSPDxxxx. Adequate mixing should shake 250uL of reagent and sample vigorously, but without splashing up. Speeds 0030 to 0050 should cover the range.

Probe X:
A bidirectional DC motor, under microprocessor control, pulls a slide via a nylon belt and nylon pulleys. The motor is dedicated to X motion of the probe. Probe X has a two-phased encoder wheel which creates pulses when passing between a reader, providing tachometer pulses to the microprocessor at the NMI input and PB4 input at 8255 U9. The one phase of the index pulley is used by the software to determine direction and accurately track the probe's position. The probe-X junction board contains some jumpers that should not be adjusted. Another phototransistor, positioned toward the right side of the probe X movement, is used to verify and if necessary, reset the probe count additionally. Another phototransistor indicates the home position to the microprocessor. LED D1 on the Main

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board provides visual feedback to the service technician of the tach pulses and home positions. The Probe X Junction PCB holds the motor driver. The main PCB holds the limit logic and connects to the Probe X Junction PCB via a 10-pin ribbon cable and power.

Probe Z:
A bidirectional DC motor, under microprocessor control, turns a 1/4-20 machined brass lead screw via neoprene belt and nylon pulley. The motor is dedicated to the vertical Z motion of the probe. Probe Z uses a shuttle with an attached aluminum code wheel that has index holes which create pulses when passing between an IR LED and a phototransistor, providing tachometer pulses to the microprocessor at the CLK0 input at 8254 U5. There is a phototransistor positioned at the extreme of the probe Z movements. It will disable the motor drivers U27 via NAND gate U18 when the travel limits are reached. Additionally other phototransistors indicates the home positions to the microprocessor. LED D2 provide visual feedback to the service technician of the tach pulses and home positions. The Probe Z Junction PCB holds the motor driver and interfaces to Probe Sense board. The main PCB holds the index pulse buffers, limit logic, and connects to the Probe Z Junction PCB via a 10-pin ribbon cable.

Washer:
One bidirectional DC motor, under microprocessor control, turns a 3/8-16 machined stainless steel lead screw via neoprene belt and nylon pulley. The motor is dedicated to vertical Z motion of the wash head. The pulley has several index holes which create pulses when passing between an IR LED and a phototransistor, providing tachometer pulses to the microprocessor at the CLK0 input at 8254 U16. Phototransistors, disables the motor driver U11 via NAND gate U10 when the travel limits are reached. Travel limits are indicated by encoder flag slot attached to the washer shuttle. The 7-segment LED on the daughter board provides visual feedback to the service technician of the tach pulses and home positions. The plate mover junction PCB contains the motor drivers and connects to the daughter board via a 26-pin ribbon cable. The daughter PCB holds the index pulse buffer, and limit logic.

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2.10 Plumbing

2.10.1 Pressure and Vacuum

Solid-state sensors P1 and P2 on the Daughter board are amplified at U6 and U8 and time division multiplexed via U9 into V/F convertor U14, then measured at 8254 timer U2. This provides feedback to the microprocessor for coordinating pump activity and displaying measured pressure and vacuum levels. The vacuum pump is driven by U3 and MOSFET Q2A. The valves are driven by U3 and U15.

2.10.2 Pumps and Valves

Refer to Figure # 1.3.12 for pictorial and Appendix E for Fluid System Schematic diagram. A diaphragm pump and valves, under microprocessor control via the daughter PCB, are switched on and off to generate pressure or vacuum as necessary. Two electromechanical valves, the pressure control valve and the bleed valve, are used to control and maintain the pressure in the system's wash and rinse bottles. The pressure control valve, controlled by U3, is an intermittent duty valve which regulates the pressure in the wash and rinse bottle. When energized, the valve closes, causing pump pressure flow to be diverted from ambient into the check valve and into the bottles and sensor. The bleed valve allows the instrument to relieve pressure during standby and when power is removed. The bleed valve is a continuous duty valve, also controlled via U3, and is continuously closed during any pressure cycle. It also serves as an emergency pressure relief valve in the event of power failure or microprocessor crash and opens when pressure is no longer required such as in standby or when timed out. A check valve, oriented to allow flow to the bottle side only, assures that the pressure is maintained on the bottle side of the system. Pressure is sensed by the circuit of P2 and U8.

Pressure build up occurs in the wash and rinse bottles simultaneously, producing positive wash and rinse fluid pressure in the wash and rinse lines of the system (see Appendix E). Two intermittent duty valves called the Rinse Valve and Wash Valve, which are normally closed, are pulsed open via U3 on the Daughter Board. The valves are used to regulate the flow of rinse and wash fluid to the washer head by precisely timed openings.

When the control valve is open to ambient and the pump is running, the pressure will not change and only vacuum will be produced by the pump.

The vacuum side of the pump is connected to the waste bottle. Vacuum is monitored by microprocessor control by monitoring the output of solid state pressure sensor circuit P1 and U6 on the Daughter PCB and switching the pump on and off accordingly. Vacuum is not regulated but is monitored. Refer to "Error Messages", "Status Indicators", and Plumbing- Bottle Level Sensing.

2.10.3 Wash System

Dispense

The pump produces 34.5 kPa air pressure at the top of the wash and rinse bottles. The fluid is forced up from the bottle but is stopped by a solenoid pinch valve. The valve is opened for a precise interval under microprocessor control to allow fluid to flow into the dispense cavity of the wash head, where it is distributed to stainless steel capillary tubes and then into eight microwells.

Aspirate

A vacuum is applied to the waste bottle any time the pump runs. The pump is connected to a fine hydrophobic aerosol filter then connected to the waste bottle. The filter prevents liquid from entering

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the pump. The waste bottle also connects to the aspirate cavity of the wash head. The vacuum is distributed across stainless steel capillary tubes thereby aspirating the contents of eight microwells simultaneously from the plate.

2.10.4 Draining

The probe empties and flushes in the wash cup. Liquid exits the wash cup through tubing that drains into a waste trough underneath the rack mover. From there liquid drains to the drain bottle by gravity.

The washer aspirates liquid from the plate into the waste bottle. The wash trough drains, by gravity, into the Waste Trough.

2.11 Bottle Fill Level Sensing

The signal BOTLV is fed through a voltage divider to stainless steel wire probes mounted in the caps of the wash, rinse, and waste bottles. The signals are time division multiplexed via U9 into V/F convertor U14 and the resulting frequency appears at the CLK2 input of 8254 timer U2. The microprocessor reads a change in frequency which corresponds to a change in conductivity of the material between the probes. Refer to 1.3.3 and 1.3.15.

2.12 Syringe Pumps

The syringe pump is an OEM component of the ChemWell consisting of two syringe drives and one valve drive which are capable of independent operation through its own microcontroller board. The pump module has its own internal command set, and communications between the syringe pump and the ChemWell Main PCB occur serially via a 3 wire cable connected to J2 on the Main Board.

The valve has four possible positions that connect any two ports at right angles. The valve is used in only two of the four positions allowing the 2.5mL syringe to connect to either the priming tube or the interconnect tube.

Priming fluid from the prime bottle is introduced into the system by rotating the shear type valve to connect between the 2.5mL syringe and the priming tube, then drawing down on the syringe to aspirate prime fluid from the bottle. A third port, on the top of the valve, is unused.

Volume pipetting is produced by displacements generated in two syringes: 2.5 mL and 50 uL. The 2.5 mL syringe is used for large reagent volumes and the 50 uL syringe is for volumes less than 30 uL. The 50 uL syringe is attached to a “T” fitting, and does not require a valve. The syringes are connected by an interconnect tube between the valve (2.5mL) and T-fitting (50mL), and this is coupled to the pipetting system by a feeder line between the T-fitting (50mL) and a coupled line into the heat block/ probe assembly.

See Figure #1.3.13.

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2.13 Photometer

The photometer consists of a mechanism with its own electronics and additional calibration and analog to digital conversion circuitry on the Coprocessor PCB. The mechanism contains the light sources, filters, detectors and electronics. Light from four tungsten-xenon lamps passes downward though four wells in the sample plate and the samples they contain. Inside the sealed box, under the read wells, is a rotating filter wheel and four photodiode detectors. The filter wheel contains eight interference filters of various wavelengths, and is speed controlled to approximately 3 rotations per second under software control. While in motion,as each filter passes in front of the photodetector, an infrared optical switch triggers a sampling of the peak voltage by the Coprocessor board. The four voltages are then fed to four comparators which each compare the sampled voltage to the output of an exponential capacitor decay circuit. The pulse at the output of the four comparators enables individual 16 bit counters in two 8254 programmable timers. The counts are read by the microprocessor and this completes the analog to digital conversion. The photodetector output is proportional to the intensity of the light, whereas the width of the positive phase of the comparator output is proportional to the absorbance. The resistance across the log cap (RC decay) determines the base of the log (10 for absorbance) and is used to adjust the low-end absorbance calibration (gain). Another four potentiometers are used to adjust the high-end absorbance (offset) of each channel.

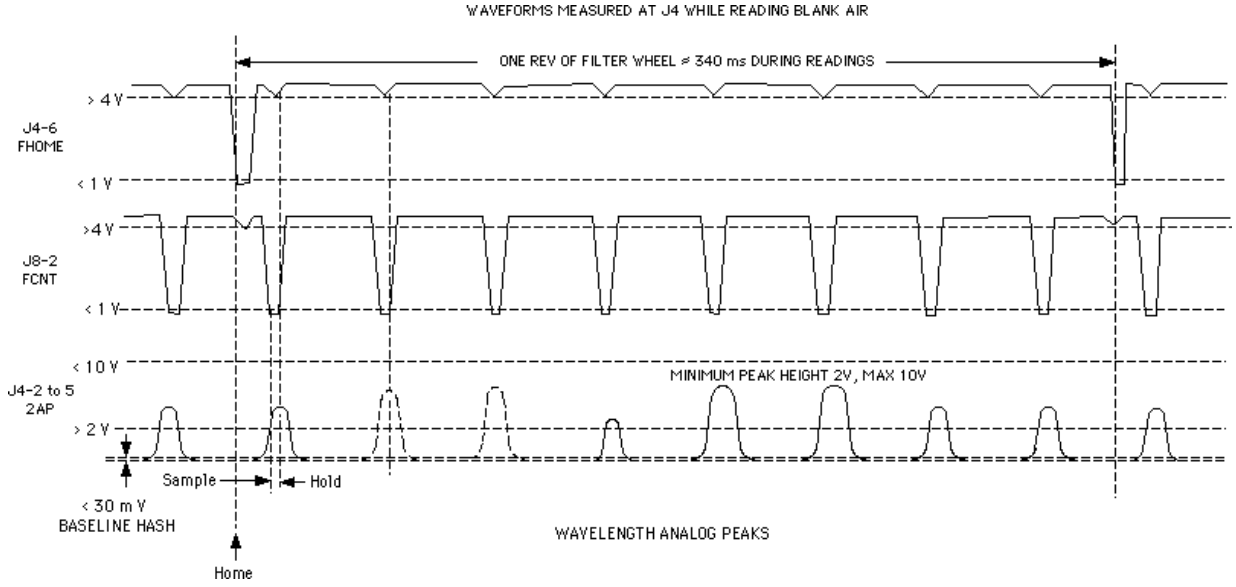

Figure #2.13 Waveform

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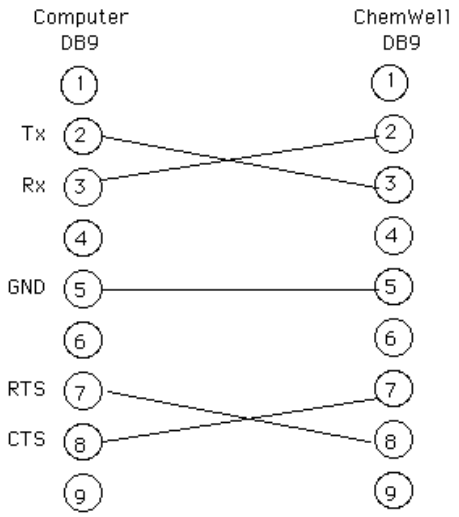
2.14 Computer Connections

The PC communicates with ChemWell via the serial port on the back of the instrument. The connector is a standard 9-pin serial port and the cable from the instrument to the PC is a standard “Null Modem Cable”. (“Null Modem Cable” is a cable made with a female 9 pin connect to another female 9 pin connector.) In this type of cable the RX/TX (receive and transmit) and the CTS/RTS lines are crossed. The serial communication is at 19,200bps, 8 data bits, no parity, and 1 stop bit.



Internally, the serial port is connected to the Main board (2900-100). The microprocessor on this board is responsible for communication with the PC and the Coprocessor and for routing commands within the ChemWell.

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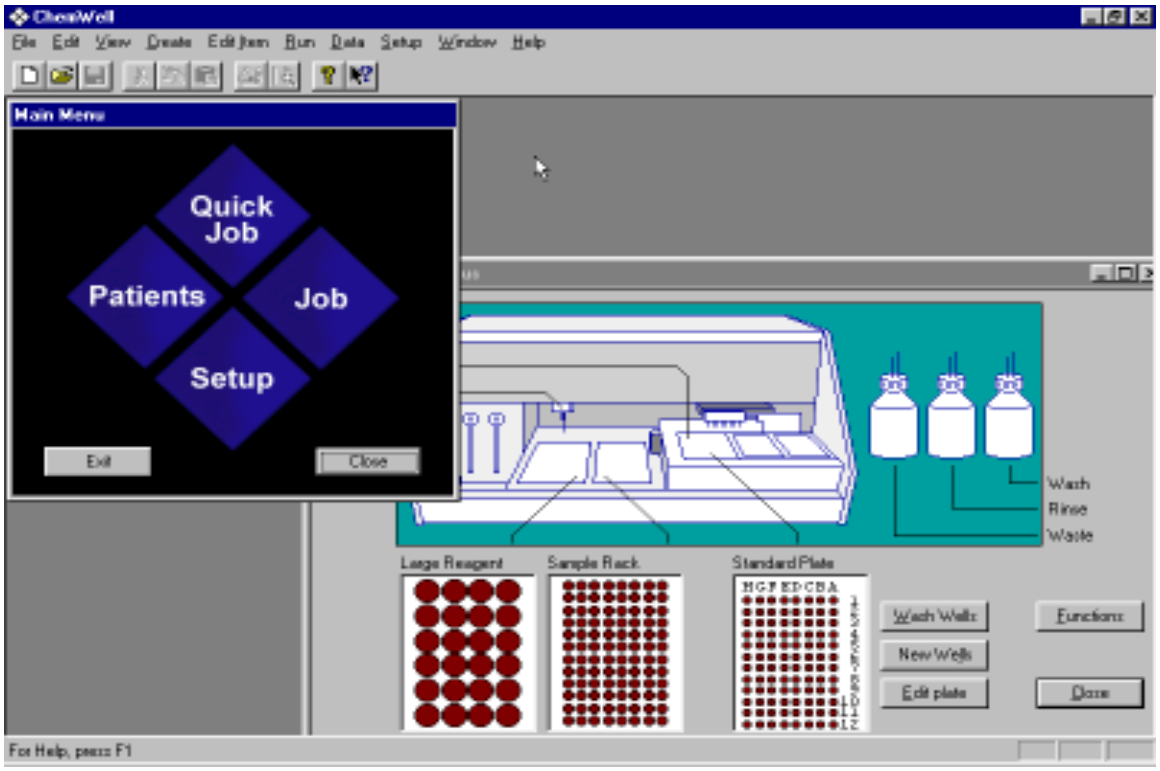
2.15 Computer Software Interface



2.15.1 Explanation of terms

Each of these terms is explained in more detail in the Owner's Manual.

Patient Database	Stores complete patient records including name, address, and doctor information.
Sample Protocol	Procedure for aspirating and dispensing reagents or samples.
Wash Protocol	Procedure for washing wells.
Method	Calculation modes and parameters for an assay.
Assay	A test, made up of protocols, parameters, and options necessary to run a test.
Panel	A group of assays that are frequently run together.
Job	Also known as a worklist, it contains the list of patients (or patient IDs) and assays to run.

2.15.2 Navigating the software

When you first start ChemWell you will be asked to log in with a username. At present this is used only for record keeping as this username will be printed in reports. It is not necessary to enter a password.

ChemWell uses the standard Windows® 95/98 Windows NT® 4.0 controls, windows, and dialogs. If you are unfamiliar with these controls and how to use them, please refer to your Windows® documentation. All of the ChemWell functions are available from the pull-down menus at the top of the program. Some of the more common functions are also available from the main menu.

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2.15.3 ChemWell status window

This window displays the current status of the instrument including the temperature and the status of the waste, wash, and rinse bottles. Also shown are the currently loaded racks and plate. The “Functions” button will start the “Instrument Functions” dialog described in the Owner’s Manual. The “Wash Wells” will wash all twelve rows of the plate currently loaded in the instrument. Use the “New Wells” button to tell the software that you have inserted a new plate or set of wells. All wells will be marked as available. The software automatically keeps track of which wells in the plate have been used. To manually edit this setup, or to mark certain wells as not available, click the “Edit Plate” button.

Note: The “Wash Wells” and “New Wells” functions are also available from the “Run” menu.

2.16 Instrument Functions

This dialog gives you easy access to some of the more common instrument functions. To open it, go to the “View” menu and select “ChemWell functions”. The following options are available:

Note: The “Start of Day” and “End of Day” functions are also available from the “Run” menu.

Start of day	Prepares the instrument to be run by turning on the photometer lamps, washing the probe, and priming the wash system.
End of day	Prepares the instrument to be shut down at the end of the day by turning off the photometer lamps, washing the probe, and rinsing the wash system.
Reset	Homes all of the mechanisms and reinitializes the syringes.
Standby	Parks the probe and turns off the pressure system.
Park probe	Moves the probe to the center wash station.
Wash probe	Washes the probe.
Prime wash	Primes the wash system with the solution in the wash bottle.
Prime Syringes	Primes the syringes with fluid from the prime bottle.
Prime rinse	Primes the wash system with the solution in the rinse bottle.
Wash Wells	Washes all twelve rows of the plate.
Heat to 37°C	Raises the coil and plate temperature to 37°C.
Temp Off	Turns the coil and plate temperature off.

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3.0 Troubleshooting

In this section, each subassembly or component group is discussed, and possible problems and solutions are outlined.

3.1 Service Tools

3.1.1 Test Mode

When servicing the instrument it is often necessary to be able to send commands directly to the ChemWell. This can be done by selecting “Telix Mode” from the View menu. This mode displays the communication with the instrument and allows the commands to be typed in and executed. For an explanation of the ChemWell commands see Service Tools- Software Service Commands.

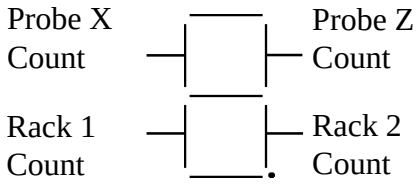
⚠ Caution: It is possible to damage the instrument by sending incorrect commands.

3.1.2 Status Indicators

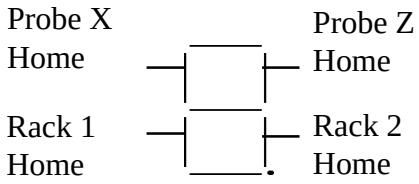
Main Board:

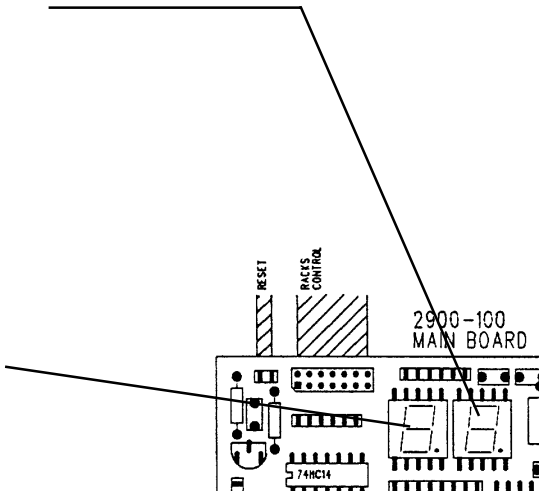
There are two 7 Segmented LEDs.

D1 shows the index pulses.



D2 shows the homing.





Probe Sense Board:

LED status indicators on the Probe Sense PCB show whether or not the heat is on. LED D11 shows the heat for the heater coil, LED D8 shows the probe heat.

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Coprocessor Board:
LED D10 shows the status of power supply, and should always be on.

Daughter Board:
LED D12: Plate Y slot indexing. LED D13: Plate X slot indexing.

LED 7 Segment

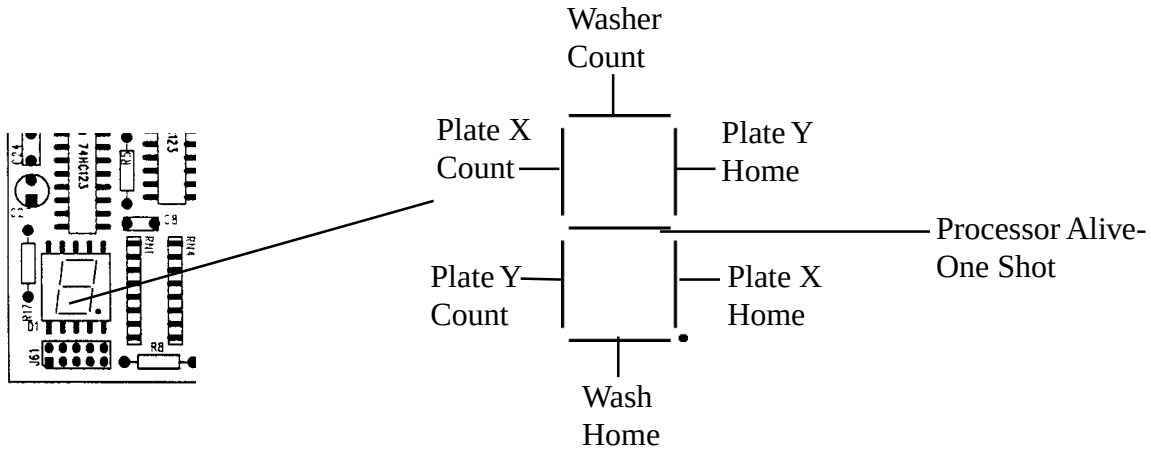
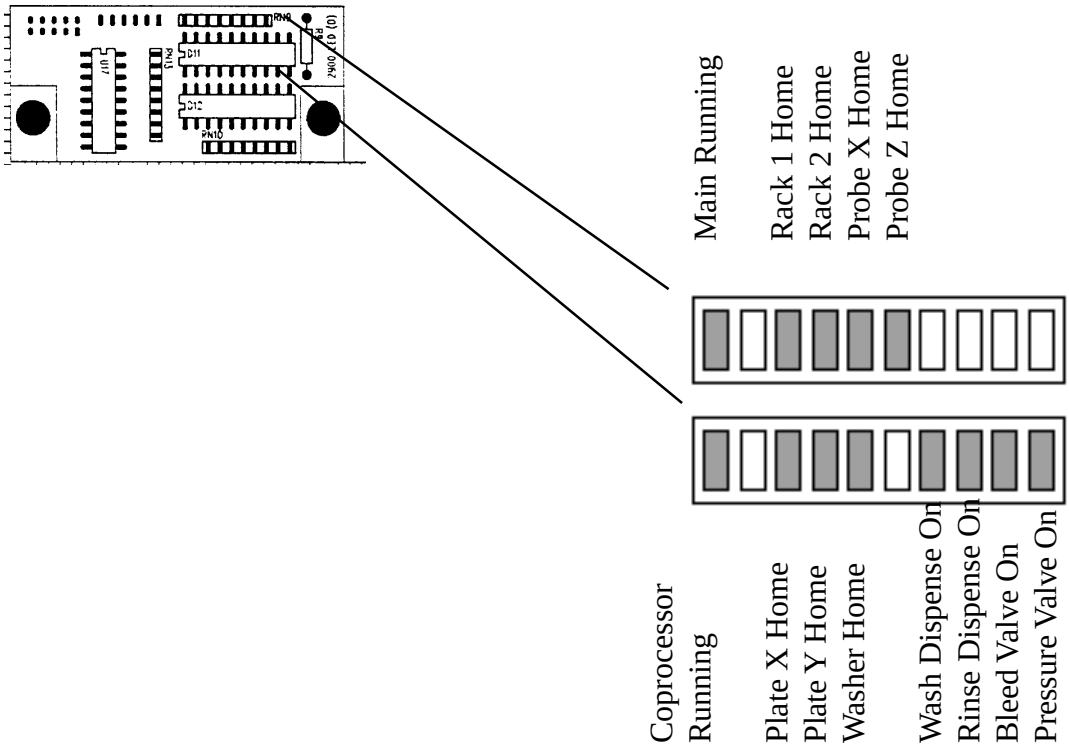


Plate Mover Junction:
LED D14: status indicator of the thermistor on the Plate heater. LED D15: currently not in use.

LED Display Board:



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3.1.3 Reports

The ChemWell software includes a number of functions intended to make it easier to diagnose problems in the field. For example, there are several files and reports which the end-user can send back to the service center. At the top of every report printed by ChemWell is a message in the form:

ssss/v.vv bbb/xxxx/yyyy/ppp-ddd

ssss	Instrument serial number
v.vv	Software version number
bbb	Software build number
*	See note
xxxx	Main firmware revision
yyyy	Coprocessor firmware revision
ppp	Primary filter (if the report is for a a single assay)
ddd	Differential filter (if the report is for a a single assay)

* If a set of parenthesis with another v.vv and bbb appear, you are viewing a data file with a different version than the data file was created under.

3.1.4 Updating the default reports

The ChemWell software includes a set of default report templates including a template for each mode and for various special reports. The user can edit these default reports, but the software contains a way to restore them to their original form at any time. This may become necessary if the user-edited report templates contain errors which prevent them from being used. From the Setup menu of the software, select Preferences and then Default Reports. The Default Reports Setup dialog will be shown. Select the button “Restore/Update all default report templates” to restore all of the standard templates. It is recommended that custom reports be created by first copying one of the default reports to a new name. For more information on report templates please see the Report Template Specification in the Owner’s Manual.

3.1.5 System Info Report

The system info report provides information on the computer that is running the ChemWell software. To access this report, select “System Info” from the “Help” menu of ChemWell.

The Windows® version section will report information regarding the Windows® installation. In Windows® 95 the “SP” section will report the system revision.

CAUTION: There are several known problems with the versions of Windows® 95 prior to ‘B’ which do affect ChemWell. If the user has one of the earlier versions of Windows® 95 the system should be upgraded.

ChemWell has been tested with Windows® 95B, 95C, 98, Windows NT® 4 Workstation, Windows NT® 4 Server, and Microsoft® Windows® 2000 Professional, Beta 3.

The Processor section will show information regarding the computer itself. The MHz speed of the computer is not available under Windows® 95/98. The Memory section will report the total amount of

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physical and virtual memory. There should be at least 8MB (8096K) of physical memory. The total virtual (Page) memory should be at least twice the physical memory. If it is not, the user should change the virtual memory settings under the Windows Control Panel.

3.1.6 Using ChemWell Pack

ChemWell Pack (CWPack) is a supplemental stand-alone program designed to ease the transfer of various ChemWell data files (assays, jobs, racks, data, etc.). Because the functionality of ChemWell Pack will eventually be integrated into the main ChemWell program, CWPack has been kept intentionally simple and inflexible. Contact your dealer if you do not have CWPack on your computer.

There are two basic operations that CWPack can perform, packing and unpacking.

Packing files:

To pack a group of files, perform the following steps:

- Using the "File Management" functions within ChemWell, export all files to be transferred to an empty directory.
- Start CWPack by selecting on the Windows Start Menu -> Programs -> ChemWell -> ChemWell Pack. There is a checkbox option: "Unpack files", and two directory/file name entry boxes: "ChemWell Export Directory" and "Package File Name"
- Make sure the "Unpack files" option is not checked.
- "ChemWell Export Directory" always defaults to "a:\chemwell". If you exported your files to a different directory, enter the name of that directory here.
- "Package File Name" always defaults to "a:\chemwell\CWPack.pck". If you would like the pack file to go into a different directory, or have a different name, enter that information here.
- Press the button labeled "Start".
- CWPack will now process the ChemWell export files into a pack file. When it is done, the status window will report "Pack Successful!".
- You may now transfer and/or email the .PCK file to it destination.

Unpacking files:

To unpack a packed file, perform the following steps.

- Start CWPack by selecting on the Windows Start Menu -> Programs -> ChemWell -> ChemWell Pack. There is a checkbox option: "Unpack files", and two directory/file name entry boxes: "ChemWell Export Directory" and "Package File Name"
- Make sure the "Unpack files" option is checked.
- "ChemWell Export Directory" always defaults to "a:\chemwell". Enter the name of a new or empty directory here. **Do not enter the name of your ChemWell data directory here.**
- "Package File Name" always defaults to " a:\chemwell\CWPack.pck ". Enter the name of the file to be unpacked here.
- Press the button labeled "Start".
- CWPack will now process the packed file and put the files into the directory you specified. When it is done, the status window will report "Unpack Successful!".
- You may use the "File Management" functions within ChemWell to import the data files.

Additionally, once CWPack has been run at least once, you can double-click on a .PCK file from within Windows Explorer, and CWPack will start automatically with the "Unpack files" option already checked,

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and the name of the .PCK file already in the “Package File Name” entry. In the “ChemWell Export Directory” box, enter the directory name of your choice.

3.1.7 Instrument Report

With the computer connected to the instrument and the instrument turned on, select “Instrument Setup” from the “Setup” menu of ChemWell. Once the software has gathered the necessary information from the instrument the “Print Report” button will be enabled. This report displays several vital statistics regarding the instrument and the configuration stored in the computer. For an explanation of these functions see the following.

Communications

ComPort	the name of the port ChemWell is using. Usually COM1 or COM2.
ComSpeed	should always be 19200
Handshaking	should always be 1

Settings

AirPlug
This is the size of the air gap, in microliters, that is aspirated following a pickup. 1µL is the default and should always be sufficient.

DispenseHigh
The is a height, in counts, relative to the bottom of the well. This specifies that position at which the instrument will dispense when "Dispense High" is specified in the sample protocol. The default is 42.

DispenseLow
The is a height, in counts, relative to the bottom of the well. This specifies that position at which the instrument will dispense when "Dispense Low" is specified in the sample protocol. The default is 35.

LevelDetectOffset
The level detect offset is used by the software to account for the difference between the detected liquid level and the actual liquid level. The default is 0 and should not be changed.

MinSampleDispense
This is the minimum amount that will be dispensed, including push volume. The default is 5µL.

MixExtraTime
This setting is no longer used.

MixSpeed
This setting is no longer used.

PrbZAspirateFactor
When aspirating from a bottle or vial, the software calculates the ideal distance to move into the vial to aspirate the specified volume. This factor is applied to calculation to account to variation in vial sizes and wall thickness. The default is 1.35 (35%).

PrbZMinimumDip

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This is the minimum amount, in counts, that the software will move the probe into the liquid when aspirating. The default is 6.

PushVolume
This is the default Push Volume used when creating a new assay. See the sections on assay programming in the owner's manual for more information. The default is 25µL.

ReagentCutoff
Sample protocols dealing with volumes less than or equal to this cutoff are treated as "samples". If the volume is greater or there is a dispense to ALL the protocol is treated as a "reagent". This distinction controls which aspirate/dispense method is used. See the sections on assay programming in the owner's manual for more information. The default is 20µL.

ReagentVolFactor
This is the amount of extra volume aspirated when picking up reagent. This extra volume is necessary to prevent reagent dilution. The default is 1.20 (20%).

SampleVolFactor
This setting is no longer used.

SetAirSpeed
This is the speed at which air gaps are created. The default is 2 and should not be changed.

Parameters
This is the unformatted list of parameters direct from the instrument. Please see the command list an alignment sections for information on these parameters.

3.1.8 Software Service Commands

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There are several software maintenance commands that are also available. None of these functions are required for normal operation but they can be used to fix some problems relating to data integrity. To use these functions, type the above command into Telix window as if sending to the instrument.

~HELP	Show Summary of these commands.
~JPRG	Purge all the data files from a selected job.
~JIDX	Rebuild the Job Index file. If the file JobIndex.IDX in the \JOBS subdirectory becomes damaged this function can be used to restore it. This make take a long time to complete if the computer contains a large amount of data.
~JFIX	Searches for damaged job and data files on the computer and prompts to fix them.
~AIDX	Rebuild the Assay Index file. If the file AsyIndex.IDX in the \ASSAYS subdirectory becomes damaged or assay files have been manually moved, this function can be used to force the index file to be rebuilt.
~ PRMR	Resets all instrument parameters to last known values. Instrument will then restart. Use with caution.
~REGR	Restores registry settings to program defaults. See “Registry” section.

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3.1.9 Available Tests Commands

Commands (listed below) start with a '!' followed by the four letter command code and any additional necessary parameters. The line ends with a CR (carriage return).

ex: !PLTM02000300<CR>

If the command is invalid an error message will be sent back. If the command is valid the entire command will be echoed and the instrument will begin processing. When the command is complete, the entire command will once again be sent back but with the first character (formerly a '!') changed to a '#'.

ex: #PLTM02000300<CR>

A line beginning with a '@' denotes a position report. It will consist of the location of each of the 7 axes in the following order: Rack 1, Rack 2, Plate X, Plate Y, Wash Z, Probe X, Probe Z

ex: @0200 0100 0225 0400 0001 1520 0050<CR>

A line starting with a '%' is a status report. The "Telix Mode" window of the ChemWell software will display this information in a self-explanatory categories.

ex: %12.0 5.1 37.4 —.- —.- E F F w —.- Next Rd: none<CR>

Lines beginning with a '*' are error messages. The three numbers following the asterisk will be the error code, followed by a colon and then the text message. Error numbers greater than 499 originate from the Coprocessor.

ex *001:Invalid number of parameters<CR>

Lines that begin with a '-' are additional information. Returned parameters, settings, or configuration etc.

ex: -SERN :0000<CR>

Coordinates are always given in 100ths of inches, 0100 = 1 inch. The home position is 0000. Note: Commands from the instrument will have a checksum inserted between the end of the string and the carriage return. The "Telix Mode" window of the ChemWell software will normally hide the checksums, but they will be visible if using a different communications program.

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3.1.10 General Commands

!1	Repeat the previous command
!INIT	Initialize (home) all axes
!HOME	Initialize (home) all axes
!SERN	Show the serial number, returns: "-SERN: xxxx"
!POSI	Display position of all axes
!STAT	Display temperatures, vacuum, pressure, status of bottles
!REVS	Report the software revisions
!PARM	Display the current parameters
!PARMnapppp	Edit a parameter. n = par.#, a = par. label (xyz,ect.), pppp = new par. value

3.1.11 Plate X/Y Control

!PLXH	Move plate X-axis to home
!PLYH	Move plate Y-axis to home
!PLTH	Move both plate X & Y to home
!PLXMxxxx	Move plate X-axis to coordinate xxxx
!PLYMyyyy	Move plate Y-axis to coordinate yyyy
!PLTMxxxxyyyy	Move plate X & Y to coordinates
!YREF	Reference the plate Y-axis again the indexing sensor

3.1.12 Mixing

!MXONtttt	Turn on plate mixer, tttt = time in seconds
!MXOF	Turn off mixer
!MSPDssss	Set mix speed duty cycle, ssss = duty (0030 is the default). A larger number results in a slower mix speed.

3.1.13 Wash Head Control

!WSHH	Move wash head to home
!WSHMzzzz	Move wash head to coordinate zzzz

3.1.14 Probe X/Z Control

!PRXH	Move probe X-axis to home
!PRZH	Move probe Z-axis to home
!PRXMxxxx	Move probe X to coordinate xxxx
!PRZMzzzz	Move probe Z to coordinate zzzz
!PRBMxxxxzzz	Move probe X & Z to coordinates.
!PFFR	Find fluid level on rack (sense liquid level)
!PARK	Move probe to waste area of wash cup.
!PSENxxxx	Set fluid sensitivity, xxxx = sensitivity level
!PCNT	Show probe counts

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3.1.15 Temperature Control

!COON	Turn on probe coil temperature control
!COOF	Turn off probe coil temperature control
!COILtttt	Set the coil temperature control point, tttt = temperature. ex: 0370 = 37°C
!TCON	Turn the plate temperature control on
!TOFF	Turn the plate temp control off
!PLATtttt	Set the plate temperature control point. tttt = temperature. ex 0370 = 37°C
!TCHK	Check if the plate temperature is 37°C ± 0.1
!PTON	Show external temperature probe
!XMPTxxx	Transmit xxx seconds of readings from thermistors.

3.1.16 Rack Control

!RK1H	Move rack 1 (left) to home
!RK2H	Move rack 2 (right) to home
!RK1Myyyy	Move rack 1 to coordinate yyyy
!RK2Myyyy	Move rack 2 to coordinate yyyy
!RKSMxxxxyyyy	Move both racks at the same time. xxxx = coord.for R1, yyyy = coord. for R2

3.1.17 Pressure/Vacuum and Valve Control

!PRON	Pressure system on
!VAON	Vacuum system on
!VOFF	Vacuum system off
!STBY	Standby. Turns off both pressure and vacuum.
!SPRSxxxx	Set the pressure control point. xxxx = PSI. ex: 0040 = 4.0psi.
!VCALxxxx	Set or display volume calibration. xxxx = volume in mL.
!SSEN	Show sensor levels. -Wash:xxxx Waste:xxxx Rinse:xxxx xxxx = counts

3.1.18 Diluter Control

!WPRBvvvv	Wash probe tip. vvvv = volume in uL, 2000 = 2.0mL, if vvvv is not specified the default is used.
!PWSH	Specifies the default probe flush volume. See !PARM and !WPRB.
!DINIx	Initialize the syringe pumps. x = number of times.
!DPRIn	Prime the syringe pumps. n = number of times to prime.
!DCALxxxx	Scale factor for small syringe. ie. 1000 => multiple specified volume by 1.000.
!DASPvvvvSx	Aspirate into syringe. vvvv = volume in uL (large or small chosen automatically). x = syringe speed.
!DDSPvvvvSx	Dispense from the syringe. vvvv = volume in uL, x = syringe speed.
!DMAPvvvvSx	Make immediate air pocket, vvvv = volume in uL, x = syringe speed.
!SAIRxxxxSx	Set air pocket size xxxx = volume, x = syringe speed. This air pocket will be added automatically after each wash probe.

3.1.19 Photometer

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!FLTS	Display the available wavelengths.
!CABS	Set the absorbance calibration factor.
!SFAC	Show the absorbance calibration factor.
!LPON	Turn the lamps on.
!LOFF	Turn the lamps off.
!RFLT	Display the filter voltages of the 4 channels at all 8 wavelengths.
!RROWAnnpdnB	Read row (8 wells). nn = strip(1-12), pd = filters, n = # of readings.
!RWELxnnpdnB	Read the specified well. x = strip(A-H), nn = strip(1-12), pd = filters, n = # of readings.
!VWELxnn	Display the filter volts at well position. x = strip(A-H), nn = strip(1-12)
!RAIR	Take and store an air reading.
!BLNKxnn	Read and store blank values, x = strip(A-H), nn = strip(1-12), entered for Channel #2 ((right rear) (all 4 channels, all 8 wavelengths- refer to error 523.))
!SBLK	Displays current stored channel blanks.

3.1.20 Probe Macros

!GOWLxnn	Go to the specified well. x = strip(A-H),nn = strip(1-12).
!GOWDxnnvvvvSs	Go to the specified well and dispense, x =strip(A-H), nn =strip(1-12), vvvv = vol. in uL, s = speed(0-9)
!PLVLxxxx	Probe dispense level at plate height from well bottom to disp. point
!WELZpppp	Change Depth of well in relation to probe. pppp = new depth
!MAXZxxxx	Max probe depth, xxxx = maximum depth over racks.
!GOR1nn	Go to the specified position in Rack 1, nn = position number.
!GOR2nn	Go to the specified position in Rack 2, nn = position number.
!GR1AnnvvvvSs	Go to the position in Rack 1 and aspirate, nn = position, vvvv = vol. in uL, s = speed (0-9)
!GR1DnnvvvvSs	Go to the position in Rack 1 and dispense, nn = position, vvvv = vol. in uL, s = speed (0-9)
!GR2AnnvvvvSs	Go to the position in Rack 2 and aspirate, nn = position, vvvv = vol. in uL, s = speed (0-9)
!GR2DnnvvvvSs	Go to the position in Rack 2 and dispense, nn = position, vvvv = vol. in uL, s = speed (0-9)

NOTE: The above commands will be automatically translated by the ChemWell software into commands of the following form. This allows the software to automatically accommodate the different racks that can be loaded into the instrument.

!GORKnyyyyxxxx	Move probe to rack. n = rack#, yyyy = rack pos., xxxx = probe X pos.
!GRKAnyyyyxxxxzzzzvvvvSsaaaa	Goto rack and asp. n = rack#, yyyy = rack pos., xxxx = probe X pos. zzzz = probe dip, vvvv = volume in mL., s = speed (0-9), aaaa = air pocket in uL.
!GRKDnyyyyxxxxzzzzvvvvSs	Goto rack and disp. n = rack#, yyyy = rack pos., xxxx = probe X pos. zzzz = probe dip, vvvv = volume in mL., s = speed (0-9)

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3.1.21 Washer Functions

!WSETxxxx	Set the wash head depth to use when washing, xxxx = depth.
!WPRI	Prime the wash system one time.
!WDISvvv	Dispense v uL from wash head. vvv = volume per will in ul.
!RPRI	Prime the rinse system one time.
!ASPSsseed	Aspirate on the plate. ss = start strip(1-12),ee = end strip(1-12),d = “D” for double
!DSPSsseevvv	Dispense on the plate. ss = start strip(1-12),ee = end strip(1-12),vvv = vol. in uL.
!ASDSsseevvv	Do an aspirate/dispense on plate. ss = start strip(1-12),ee = end strip(1-12), vvv = vol. in uL.
!RWSHnnvvvx	Wash row nn, vvv vol in uL, x = number of cycles.
!WASH	Set current bottle to Wash. Performs automatic prime.
!RINS	Set current bottle to Rinse. Performs automatic prime.
!BOTT	Show current bottle setting (wash or rinse).
!BCHK	Check bottles levels. Will report if there is an error.
!CASP	Check wash head aspiration (must change 0.5" open versus closed system)

3.1.22 Service Functions

!IOFF	Disable timed homing
!IDON	Enable timed homing
!RSET	Complete reset of the instrument

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3.2 Error Messages

Error messages are displayed when the instrument fails to operate correctly. They are intended to help the operator locate the problem. If error messages appear frequently, a hardware problem is usually indicated.

Errors reported from Main processor go up to 499.

*001: 'Unknown command',
Check command for spelling and validity.

*002: 'Parameter exceeds allowed range',

*003 : 'Too few or wrong parameter(s)',

*004: 'Command has not been implemented',

*005: 'Fluid has not been detected in programmed range',

*006: 'Probe Z axis is jammed' or 'Probe Z is jammed',
The motor stalled while the instrument was attempting to move the probe in the Z direction. Check for mechanical obstructions or broken belts. Check motor driver U27 and associated logic. Check the sensors. Make sure the transistor and LED are aligned.

*007: 'Probe X axis is jammed' or 'Probe X is jammed',
The motor stalled while the instrument was attempting to move the probe in the X direction. Check for mechanical obstructions or broken belts. Check motor driver U23 and associated logic. Check the sensors. Make sure the transistor and LED are aligned.

*008: 'Rack 1 is jammed',
The motor stalled while the instrument was attempting to move the rack 1. Check for mechanical obstructions or broken belts. Check motor driver U22 and associated logic. Check the sensor. Make sure the transistor and LED are aligned.

*009: 'Rack 2 is jammed',
The motor stalled while the instrument was attempting to move the rack 2. Check for mechanical obstructions or broken belts. Check motor driver U22 and associated logic. Check the sensor. Make sure the transistor and LED are aligned.

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*010: 'Diluter Not acknowledging',
Check the cable that plugs in the back of the diluter.
*011: 'CSI/O Inactive',
Unable to communicate with coprocessor.
*012: 'Incorrect length for Move All command',
*013: 'Timeout waiting for coprocessor message',
*014 'Diluter is not responding',
*015: 'Timeout waiting for completion of last coprocessor command',
*016: 'Check reagent/sample level!!!',
*017: 'Probe dip too large!',
*018: 'Probe sensor malfunction',
*019: 'parameter checksum error',
*020: 'probe jammed while level detecting',
*021: 'small syringe stroke error',
*022: 'large syringe stroke error',

The Coprocessor error messages start at 500 and go up.

*501: 'Parameter exceeds allowed range',
*502: 'Too few parameters ',
*503: 'Command has not been implemented',
*504: 'Plate X axis is jammed',
*505: 'Plate Y axis is jammed',
*506: 'Wash axis is jammed',
The motor stalled while the instrument was attempting to move the wash head. Check for mechanical obstructions, broken belts, and opto alignments. Check motor driver U11 and associated logic.

*507: 'Unknown coprocessor command',
*508: 'Invalid dispense volume (25-350 allowed)',
*509: 'Wash head can not be moved unless PLX >210',
*510: 'Can not dispense unless PLX >210',
*511: 'Wash movement error. Wash aborted',
See *506
*512: 'Waste bottle is full',
Empty the Waste Bottle. The instrument detected a full condition on the waste bottle. If waste bottle is empty, dry waste cap at terminal entry points. Check sensor lead is plugged in properly. Check the sensor lead for shorts.

Wrong cap has been used. Make sure the cap with the short wires is inserted into the bottle and closed snug.

*513: 'Wash bottle is empty',

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*514: ‘Rinse bottle is empty’,

Wash/Rinse Bottles are low. The instrument detected an empty condition on the wash or rinse bottle. If the bottle is full, check that the sensor’s lead is securely connected to the bottle cap and plugged in properly. Check the sensor leads for continuity.

Wrong cap has been used. Make sure the cap with the long wires is inserted into the bottle and closed snug. The black plastic separator should be at the bottom of the wires and the wires should not be crossed or touching each other.

*515: ‘Filter wheel error’,

Wheel is not rotating. Check for NMI interrupts at the processor.

*516: ‘Pressure system error’,

Pressure not building rapidly enough, check valves, bottle caps, and tubing.

*517: ‘Vacuum system error’,

No vacuum detected, check pump and tubing.

*518: ‘Possible Aspiration failure’,

Wash head aspiration check failed (Vacuum changes .5 inches when aspirate tubes make contact with flat surface. Check pump, tubing, and wash head.

*519: ‘Vacuum over range’,

Vacuum level too high (>10 inches Hg). Check for obstruction in the head or tubing.

*520: ‘Y slot not detected’,

Plate X registration slot not detected. Check sensor at X LED on daughter board.

*521: ‘X slot not detected’,

Plate Y registration slot not detected. Check sensor at Y LED on daughter board.

*522: ‘Lamp X Failure’,

One or more of the lamps is not operating correctly.

*523: ‘Channel Blanks are not valid!!!’,

Blanks have been reset. Load wells A01, D01, D04, and A04 with 200uL of uncolored wetted solution, such as blanking solution provided, and run the command !BLNKA01.

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3.3 Valves

Make sure power is off.

Each valve uses a short length of silicone tubing. Tubing may self-adhere or become clogged with dried residue from fluids. If the valve operates but no fluid is dispensed or aspirated, the valve tubing may be blocked. To check for blocked tubing do a visual inspection. Grasp the tubing on either side of the valve body and gently stretch it. If needed, pull the tubing from the valve body. Roll the tubing between your fingers and gently stretch it. Reposition and test. If still blocked, see the section "Valve Tubing Replacement." See Appendix E Fluid System Schematic.

3.4 Vacuum and Pressure Systems

The pump requires no maintenance. If the pump runs frequently or continuously while the instrument is not in use, there is probably a leak. Check the bottle caps and fittings. Check that the tubing is firmly seated on barbs and all fittings are tight. Turn the fittings only until finger-tight. **Do not overtighten the plastic Luer fittings!** Check the operation of the valves to ensure they are closing completely. If the pressure pump runs frequently or continuously, check the bleed valve, wash and rinse bottles, and pressure system tubing for leakage. The bleed valve must be completely closed while the pressure system is on.

If aspiration is poor or absent, the exhaust filter may be clogged and should be replaced. In the event that the exhaust filter gets wet due to a waste bottle spill, it must be replaced for continued operation. See the section "Exhaust Filter Replacement."

If any valve is inoperative, (Note: Tubing must be installed in the valve for it to operate correctly.) check inputs and outputs at U3G. If the pressure / vacuum pump is inoperative, check Q2A. If the pump and all of the valves are inoperative (no voltage present at any time), check LR2 and U12H for proper operation. Both should be active at all times while the instrument is powered. The 7 Segment LED D1 on Daughter PCB should have the center line illuminated. See "Status Indicator" section.

3.5 Motor Control

All of the axes of motion are of the same basic design, a DC servo motor and a position sensor. Probe X has a two phase encoder wheel, while the other axis sensors are simpler; either a circular multislot interrupter disk, linear multislot interruptor, or plain single interrupter such as end limit sensors. Openings in linear multislot interruptors are also referred to as index slots and the interruptors are also called index brackets. The most common failure in movement can be attributed to a physical obstruction. Check for this possibility first.

Another less likely possibility is a problem with a sensor. This can usually be determined by observing the sensor's status indicator. If a problem is indicated, check the IR phototransistor and LED of the sensors. The phototransistor and LED should be perfectly aligned so that the "eyes" can see each other. Check the home sensor, pulley count, and limit sensor output. The indicator LED will show (see

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Troubleshooting- Status Indicators) the movement of the axis. On the sensor, check to see if there is 1.2 volts voltage drop at the IR LED and the IR photo transistor switches from its low state (less than .5 volts) to high state (>4.0 volts) when the “eye” is blocked . Another possibility is failure of the L293B motor driver. Each motor has its own motor driver chip. See Principles of Operation- Motor Control for specific locations.

Other problems could be with other sensors that do not have indicators, motor driver electronics, wiring, the motors themselves, or the belt. The belt should be attached correctly and moving smoothly around the pulleys.

Probe X:
The Probe X axis has a two phase Encoder Wheel and matching sensor pair **(CAUTION: The wheel is fragile. Do not damage! WARNING! The Encoder Wheel Can Cut You!)** on the left side which provides tachometer pulses to the microprocessor at the NMI input and PB4 input at 8255 U9. The two phases of the encoder output are used by the software to determine direction and accurately track the probe’s position. On the right side of X travel, there is a sensor with a phototransistor and LED that is at a known fixed point and is used as a reference to verify the encoder wheel count is correct and if not resets the count in software. An additional sensor to the far left of the mechanism senses home for the microprocessor.

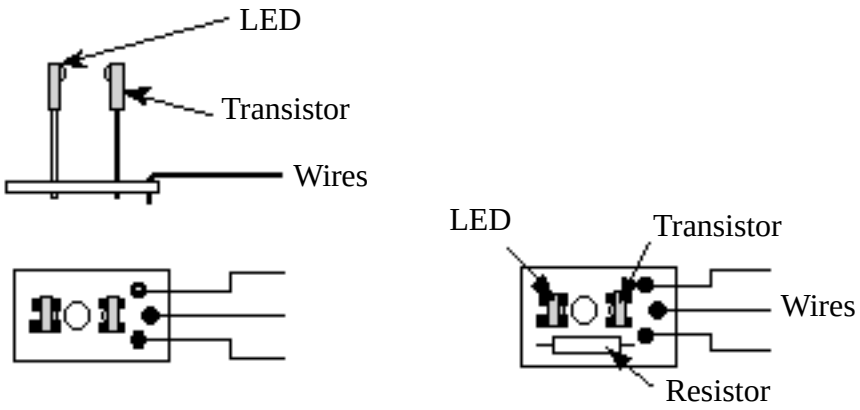

Figure #3.5.1 Typical Optical Switches- With and Without Resister

3.6 Incomplete Aspiration

One or more aspirate tubes may be clogged. Clean the aspirate tubes using the cleaning wire. Check the tubing path leading from the wash head to the waste bottle for kinked or pinched tubing. Verify the vacuum using a gauge. Check the exhaust filter for clogging. Aspirate tubes should contact the bottom of all 8 wells simultaneously while aspirating, not necessarily while positioning.

3.7 Incomplete or Inaccurate Dispense

One or more dispense tubes maybe clogged. Clean the dispense tubes using the cleaning wire. Check the tubing path leading from the wash (or rinse) bottle to the wash head for kinked or pinched tubing. Check for stuck valves, and clogged or pinched valve tubing. Check the bleed valve for leakage. Verify the pressure using a gauge.

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If the instrument has been stored for an extended period without rinsing, it may be necessary to unlcog the tubing and/or operate the valves manually in order to prime the instrument.

3.8 Photometer

The photometer consists of a mechanism with electronics and additional calibration and analog to digital conversion circuitry on the Coprocessor PCB. It can be divided into several component systems:

- Lamp, lamp terminal blocks, related mounting hardware, brackets and adjusting screws.
- Photometer PCBs for light detection , speed and position sensing.
- Filters, filter wheel, drive belts, pulleys and jackshaft, and filter wheel motor.
- Electronics: photodetector, high gain amplifiers, buffers, gain of 2 amplifiers, sample and hold, log ramp generator, voltage comparators, counters, NMI clamp.

The lamps are custom tungsten filament, xenon gas filled, lens end bulbs, rated for 6V operation and consume 6W each. They are intended to be maintenance-free for many years, since they are turned off automatically during periods of instrument inactivity. However, under heavy usage the lamps remains on for longer periods and may require replacement as the output becomes low near the end of its service life. This is also apparent by the blackening of the glass envelope. A physical shock to the instrument may necessitate lamp replacement due to filament breakage. The lamp terminal blocks and lamp guide hold the lamp in alignment with the rest of the assembly. The brackets provide adjustments in horizontal dimensions, so that the filament can be centered on the light path. The lamp must be replaced if output becomes low or the lamp fails completely. To check for low lamp refer to the service procedures section **"Photometer Output Check" (Section 4.5.1)**. If all or most of the voltages are low for a particular channel and not for other channels, or for all channels, the lamp alignment is the most likely cause. If all voltages are low, rule out the power supply by measuring the voltage at the lamp terminals. If the lamp voltage is lower than 6.0 VDC, power supply 2 or the wiring from it to the lamps may be a problem. Otherwise, refer to the section **"Lamp Replacement"** paying particular attention to the lamp alignment instructions. **Never adjust or manipulate the trim pots on the coprocessor PCB to achieve the proper filter voltages.** Doing so will destroy the calibration.

The four photometer channels, the filter wheel count CNT and NMI, and filter wheel home FHOME all originate in the photometer mechanism. The photometer PCB contains four photodiodes and very sensitive high gain op-amp circuits. Two phototransistors are positioned to see through the home and indexing holes in the filter wheel. The exciter for these transistors are 2 LEDs located on another small circuit board on the opposite side of the wheel outside the cover box. Because the photodetectors and related circuitry is solid-state, it should require no service. Do not attempt to modify the photometer PCB. Channel 1 read site is located under the lamp that is toward the front - right. Viewed from above, channels 2 -4 are located counter clockwise from 1.

The filter wheel turns on a shoulder screw shaft and is driven by the filter wheel motor via two neoprene belts. The filter wheel itself requires no adjustments. The optical interference filters contained in the wheel are of metal ion-assisted deposition (IAD) type construction and are intended to be maintenance free for the life of the instrument. However, in an environment where extreme humidity or temperature are encountered, optical characteristics on one or more filters may be compromised. Run

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Photometer Output Check as described in 4.5.1. If only one or two filter voltages are low on all channels, the filter(s) may be suspect. Refer to the service procedure **"Filter Replacement". Never adjust trim pots on the Coprocessor PCB to achieve the proper voltages**. The filter wheel speed is regulated by seeing CNT (NMI) rate and adjusting the duty cycle of the output to the filter wheel motor. When the wheel rotates the waveforms shown in the Photometer Test Points diagram (section 3.8.1) should be generated.

The electronics consist of the 4 photodetectors and associated high gain amplifiers that convert the light signals to electric analog signals and buffer followers on the photometer PCB. On the coprocessor board are gain of 2 amplifiers, sampling analog switches and hold capacitors followed with high impedance buffers. These buffers feed voltage comparators that are comparing the held light signal voltage with a logarithmic discharging voltage ramp. The output of the comparators gate the corresponding 16 bit counters clocked at approximately 2 MHz to make the analog to digital conversion. The NMI clamp diodes keep the gates from enabling the counters until the wheel rotates out of a filter count hole in the filter wheel. This begins the hold phase of the analog processing, synchronizing the start of the timer counting. At the same time, the processor uses the NMI to control the motor speed and update the filter count in software. The home is used to reset the filter count in software. The calibration is affected by trimpot adjustment on each channel at the input of the individual gain of two amplifiers (offset), and by the trimpot TP1 on the logarithmic discharging voltage ramp generator (gain). **Never adjust trim pots on the Coprocessor PCB. Contact the manufacturer if you question the calibration.**

3.8.1 Photometer Test Points

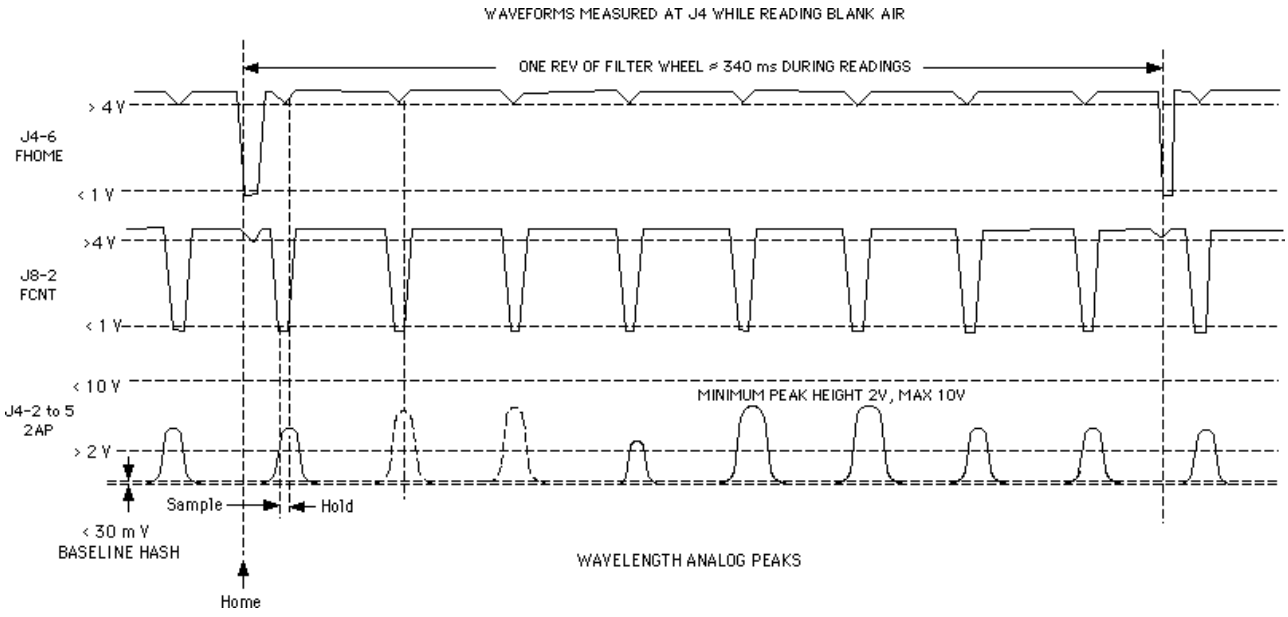

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Figure #3.8.1 Photometer Test Points

3.9 Plate Temperature Control

The plate carrier contains a thermistor and a heating element totaling 12 ohms which are used to provide the temperature control. The heat element is switched on and off under software control using the MOSFET Q11 on the plate junction board. LED D14 on the plate junction board indicates that the heat strip is on.

The thermistor circuit in the plate is brought through the plate junction board and back to the Daughter board where it is fed into the amplifier at U20A. The circuit is calibrated using the trimpot R28 on the Daughter board. The output from this amplifier is fed into the demultiplexor CD4051 U9, then into the voltage to frequency convertor AD654 U14. The output from the VF is read by the 8254 U2 on pin 9. The coprocessor firmware controls both the demux and VF to read all temperature, pressure, vacuum, and bottle sensors which use the VF circuit.

To check the current coil temperature send a !STAT command. The “Telix Mode” window will display the plate temperature in the top-left status box under “Plt:”. To turn the plate temperature control on use the command !TCON and to turn it off send the command !TOFF. !PLATxxxx (example: !PLAT037 for 37 degrees) will adjust the target temperature. Software control is enabled for 25°, 37°C and off (room temperature).

3.10 Coil Temperature Control

The tubing from the probe is wound in the coil block, allowing reagents to be prewarmed before being dispensed to the plate. The coil block is heated under the control of the Main board firmware to the specified temperature.

A change in resistance of the coil thermistor at J55 of the probe sense board causes the frequency of the oscillator U29B to change. This frequency is fed into the 8254 U10 on pin 9 where is read by the software. The temperature is calibrated via the trimpot R23 on the probe sense board. See the section on calibration. The drive to the coil heat is provided by one gate of the L293 driver chip on the probe Z junction board, which in turn drives the (4) 75ohm heat resistors on the underside of probe sense board. The LED D11 on the probe sense board indicates that the resistors are currently heating.

To check the current temperature setting use the !PARM command and locate the “Coil” parameter. 0370 = 37C. To check the current coil temperature send a !STAT command. The “Telix Mode” window will display the coil temperature in the top-left status box. To turn the coil temperature control on, use the command !COON and to turn it off, send !COOF.

3.11 Probe Temperature Control

The probe body itself is also heated but uses a self-regulating circuit, rather than being under software control. The thermistor inside the probe is fed into the comparator made up primarily of U29A on the probe sense board. The circuit is calibrated via the trimpot R20. The output of this comparator switches one of the L293B gates on the probe Z junction board. This driver provides power to the (2) 32ohm 1/8 watt resistors inside the probe. Heating is indicated by the LED D8 on probe sense board. The firmware is able to turn off the coil temperature control by disabling the L293B chip U27. Probe tempera-

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ture control is on when the coil temperature control is on. See the commands !COON and !COOF.

3.12 Carrier Temperature Control

ChemWell contains an auxiliary temperature control channel labeled on the schematic as “Carrier”. This is not presently used.

3.13 External Temperature Probe

ChemWell also contains a facility for using an auxiliary temperature probe. To use this, plug the YSI-style probe (issued to each distributor) into the jack on the front of the electronics rack, then place the probe in the position to be measured. Use the command !PTON to turn on the external probe. The “Telix Mode” window will display the temperature under “Ext:” whenever a STAT is received, or send !XMPT0060 to see external probe temperature displayed for the next 60 seconds. This probe is measured in a similar manner as the plate thermistor using the amplifier U17B and calibrated at the factory via trimpot R23 on the Daughter board. Also, see section “External Sensor”. For calibration, see 5.3 External Sensor.

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3.14 Serial Port

ChemWell uses a standard RS-232C serial port to communicate with the computer. The provided cable is a standard “null modem cable” which crosses the RX/TX (receive and transmit) and CTS/RTS (clear-to-send and ready-to-send) lines. The CTS/RTS pair is used by ChemWell for handshaking. The DTR/DSR pair is not used. Communication is at 19200 8-N-1. For more information see the command list.

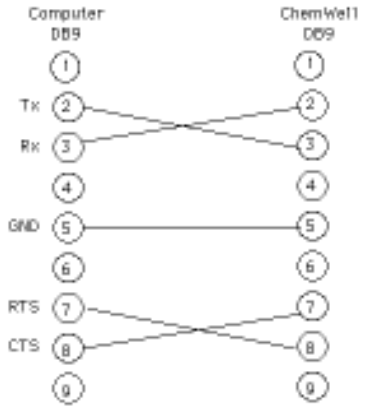

Figure #3.14 Cable Diagram

The instrument’s serial port must be connected to the ChemWell computer software for normal operation. If the instrument emits a triple-beep at startup this indicates that the instrument is unable to connect to the PC. If the communication times out, the instrument will initialize with no connection. It then must be reset using the reset button on the back of the instrument before it will resume communication with a computer. Use only a standard “Null Modem” cable to connect to the instrument to your PC.

3.15 Printers

3.15.1 Black & White

A black and white printer should be set to print in black and white.

If your ChemWell computer is hooked up to multiple printers or if you print to multiple printers on a network, you may encounter a problem if one of them is black and white with a color capable driver. If you print on a color printer and then print on a black and white printer before restarting ChemWell, it might attempt to print color on the black and whiteprinter. If you encounter this problem, restart the ChemWell software.

Known printers with this problem:
Citizen GSX-190

3.15.2 Color

Some color capable printers do not correctly print graphs on computers with limited memory. Try setting your print driver (under “Printers”) to print black & white, lower the print resolution, or upgrade your printer driver.

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4.0 Service Procedures

WARNING: Set the power switch to OFF (0) position before performing any service work on instrument.

	Ext. Cover	Lift Hood	XY Cover	Probe Shield	Aerosol Shield	Left Side Panel
Work On:						
Bottles						
Syringe Pump	x			x	x	x
Washer	x		x	x	x	
Rack Y Mover					x	
Block		x		x	x	
Probe Z Mover		x		x	x	
Probe XZ Mover		x		x	x	
Probe X Mover		x				
Photometer	x		x		x	
Filter Wheel			x	x	x	
Lamp Bracket			x		x	
Plate X Mover			x		x	
Plate Y Mover			x		x	
Plate Mover			x		x	
Any Main Board	x	x			x	
AC Assembly	x	x				
Electronic Rack	x	x			x	
Valve and Pres. Pump		x		x	x	x
Rinse		x		x	x	
Wash		x		x	x	
Bleed		x		x	x	
Pressure Ctrl		x		x	x	
Waste Trough						
Wash Cup						
Dome Lamp				x	x	
Plate Carrier			x		x	
Chassis						

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l	Right Side Panel	Plate Cover	Photo. Holder	Release Pres.	Remove Bottles	
						Work On:
				x	x	Bottles
						Syringe Pump
	x	x		x		Washer
						Rack Y Mover
						Block
						Probe Z Mover
						Probe XZ Mover
						Probe X Mover
	x	x	x	x	x	Photometer
	x	x	x	x	x	Filter Wheel
	x	x	x	x	x	Lamp Bracket
		x				Plate X Mover
		x				Plate Y Mover
		x				Plate Mover
						Any Main Board
						AC Assembly
						Electronic Rack
				x		Valve and Pres. Pump
				x		Rinse
				x		Wash
				x		Bleed
				x		Pressure Ctrl
						Waste Trough
						Wash Cup
						Dome Lamp
						Plate Carrier
						Chassis

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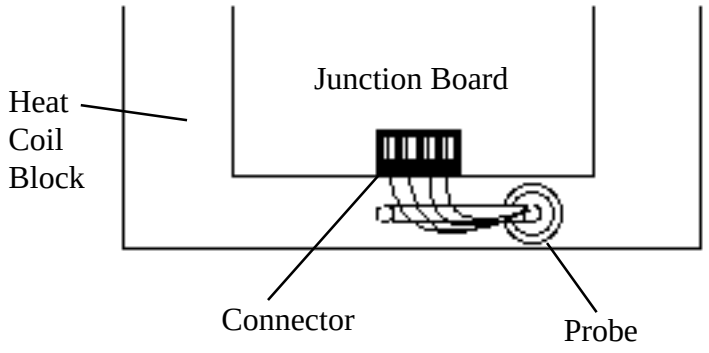
4.1 Replacing Probe

In the event that the probe supplied with the ChemWell becomes damaged, it may be replaced as follows:

First, loosen the set screw retaining the probe in the heating block with the supplied hex key. Unplug the probe's green 4-pin connector from the junction board, and pull the probe upwards until it is free from the heating block. The probe is connected to the heating coil by a length of silicone tubing which will pull free of the probe as the probe is removed. Install the new probe, making sure the black o-ring at the end of the probe body is seated firmly against the heating block. This assures that the probe is seated to the proper depth. Retighten the set screw but do not overtighten or the probe body may become damaged. Reconnect the silicone tubing from the heater coil to the end of the probe and plug the green 4-pin connector into the junction board. Verify that the probe is connected correctly. Send a !WPRB to ensure the probe is filled with Deionized water. Then send a !PCNT. The average and instantaneous counts should be approximately the same +/-3 and in the range of 2-3000. Verify that the probe connection to the heat block is secure, and that the probe is free of obstructions by performing a !WPRB command.



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4.2 Bottles

4.2.1 Clogged Tubing

Locate clogged tube. Take tubing between finger and massage debris loose. Also, see Tubing Replacement.

4.2.2 Bottle Sensors

Make sure wires are straight and not touching. The plastic spacer located at the bottom of the wash/rinse wires should remain there, providing the wires with a guide.

4.2.3 Hydrophobic Filter Replacement

The filter that removes contaminant particles from the exhaust of the vacuum pump must be replaced if clogged or damaged. If the Aspiration Failure error message appears, or if the instrument takes longer to get up to pressure, the filter may be clogged. If the waste bottle is overturned and the filter gets wet, the filter must be replaced.

To replace the filter:

1. Set the power switch to OFF (O).

2 Release Pressure from bottle set by loosening the lid on Wash and/or Rinse bottles.

3 Pull the tubing from the fittings on the filter.

4 Install the new filter with the INLET side pointing toward the waste bottle. Push the tubing on the fittings until seated.

4.2.4 Pressure Leak

Check all bottle caps for tightness, fitting connections, tubing condition, and pressure control valve. If tubing needs replacing, see Tubing Replacement section. If valve is failing, see Valve Replacement section.

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4.3 Chassis

4.3.1 Dome Lamp Replacement

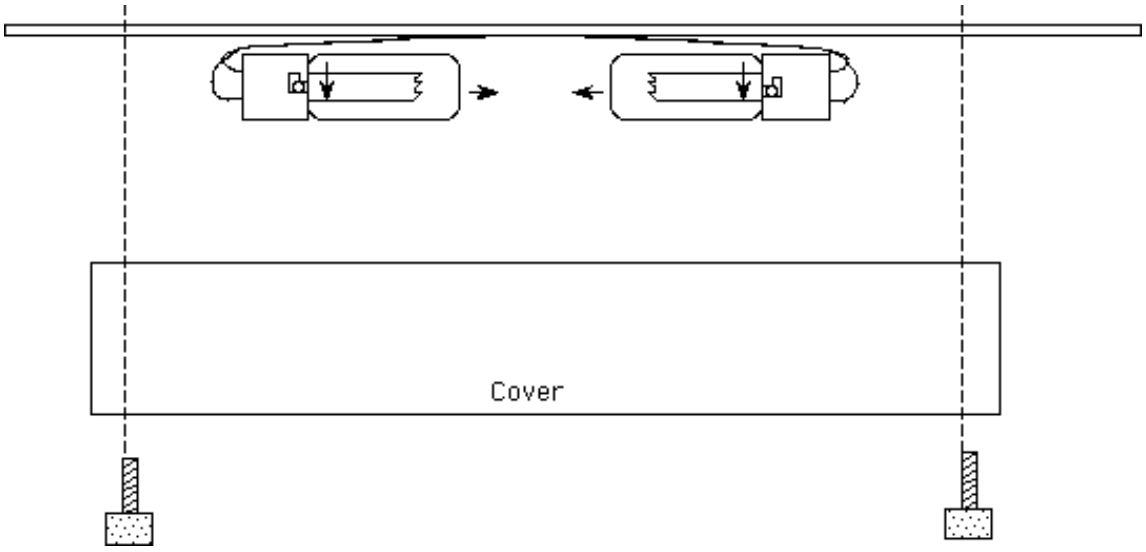

Figure # 4.3.1 Dome Light Diagram

To replace the light bulb:

Turn off the power.

Remove Dome Lamp cover.

Twist light bulb and pull out.

Install new light bulb by inserting and twisting the light bulb. Replacement light bulb is a 12 volt, .20 amp, tubular 3-1/4.

Replace cover.

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4.4 Electronics Rack

4.4.1 AC Wiring Layout

See Block Diagram in Appendix C.
PCBs

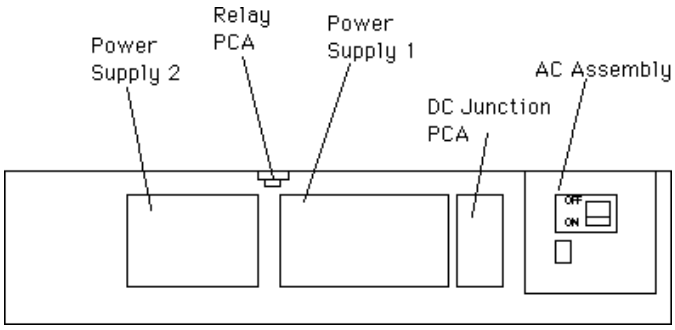

Figure # 4.4.1 Electronics Rack- Rear

4.4.2 Board Replacement

Each of the primary circuit boards is mounted to the top of the electronics rack with three #4 Phillips-head screws and internal tooth lock washers. To remove a board, first unplug all of the cables attached to it, being careful not to bend any of the pins. If removing the Daughter board, gently pull the tubing from the pressure and vacuum sensors or use a small flat-bladed screwdriver to push the tubing off of the sensor. Then, remove all three screws. If removing the Coprocessor or Daughter board, gently pull the board horizontally away from the bus interconnect (the right-angle headers at the edge of the boards). See Electronics Rack figure #1.3.11.

Follow the reverse procedure to install a new board. First insert the three screws (through washers), then reconnect all of the cables. A diagram of the cables to each board is provided on the inside of the top cover as well as in this manual.

If any of the other circuit boards should need to be replaced the procedure is similar. Each board is mounted with two or three screws, each with a lock washer. Be sure to note where each cable plugs into the board and also note the orientation. Diagrams of each board are provided in this manual.

4.4.3 EPROM Replacement

A firmware update will consist of one or two EPROMs to be installed in the instrument. To access the circuit boards, turn off the instrument and lift the top cover. The EPROM labeled “MAIN” goes in the Main board, which is the board on the left-side of the instrument. The EPROM labeled “COP” goes in the Coprocessor board, which is the middle of the three boards. The procedure for installing an EPROM is given below, and is the same for both EPROMs.

1. Locate the EPROM socket and lift the small lever at the end of the socket. This frees the EPROM for easy removal and insertion.

2. If necessary, gently bend the pins of the new EPROM so that the pins are perpendicular to the EPROM. Hold the EPROM by the body and bend the pins against a flat surface such as a table to bend

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all the pins the same amount. Do not over bend the pins, since they are easy to break if bent too far.

Figure #4.4.3 Bending EPROM

3. Install the EPROM with the notch oriented as shown in the label on the EPROM socket. The notch should face toward the left side of the instrument. Press the lever down toward the PCB until it locks into place.

4. Turn the instrument back on (with the ChemWell software running on your computer) and verify that the instrument starts normally.

4.4.4 Fuse Replacement

An inactive instrument may result from a blown fuse. However, a blown fuse may indicate a problem with the power supplies.

ChemWell contains three sets of the fuses. The main fuses are located inside the AC box which is part of the electronics rack. There is also one fuse in each of the two power supplies. Since the supplies are autoswitching and can accommodate normal voltages it is unusual that any of these fuses should require replacement.

Replacing the main AC fuses:

WARNING: Set the power switch to OFF (0) position before performing any service work on instrument.

After unplugging the instrument, locate the AC panel on the back of the unit. The panel contains the power receptacle and the power switch. Remove the two screws (one at the top of the panel and one at the bottom) that attach this panel to the instrument. Gently pull this panel away from the instrument; there will be several wires attached. Remove the four screws holding the black AC cover on the AC panel and remove the cover.

The double clip fuse holder is mounted on the inside of the rear panel. Locate the blown fuse and remove it with a fuse puller, or carefully pry it out with a small screwdriver. Install a new 1.5A, T rating, 250 V, cartridge fuse. The fuse link is in a clear glass package and the element is spirally wound on a fiberglass core. The fuses must be replaced by a 1 1/4 inch glass cartridge fuse commonly known as 3AG or size ‘0’. The nominal dimensions are 1.25 X .25 inches. (32 X 6.3 mm). The fuses must be approved to UL and CSA standards or approved for the country of use. Use only the recommended fuse. Do not substitute any other rating. Replace the AC cover. Also, check fuses on power supply boards.

Fuse: 3AG, 1-1/2 Amp, 6.3mm X 32mm, T Slow Blow

Follow the reverse of the procedure above to replace the AC panel.

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Power supply fuse replacement:

WARNING: Set the power switch to OFF (0) position before performing any service work on instrument.

Unplug the instrument and remove the four screws that attach the back panel to the unit. Each of the two power supplies contains a fuse on the AC mains. CAUTION: The two power supplies do NOT use the same types of fuses, make sure to install only the proper fuses.

The first power supply (larger of the two)uses a:	Size 0 (or 3AG, 32mm X 6.3mm), 5 amp, 250V, quick blow
the second (smaller power supply board) uses a:	Size 5mm X 20mm, 2 amp, 250V, quick blow

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4.5 Photometer

The instrument incorporates solid-state electronics in a very reliable field-proven design. If you experience problems, please contact the manufacturer.

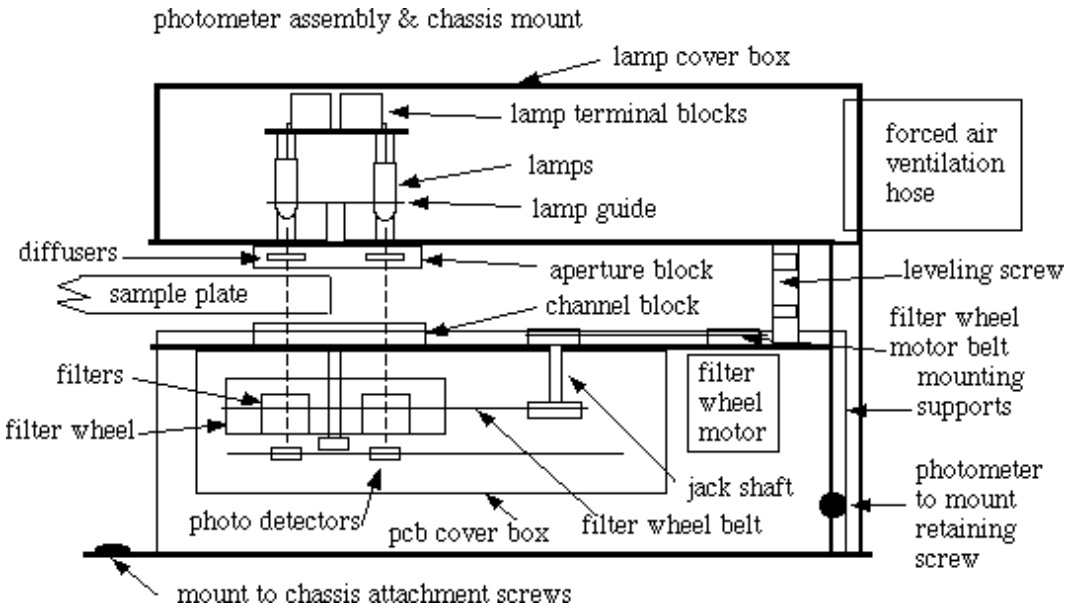

Figure #4.5 Photometer Diagram

4.5.1 Photometer Output Check

Go into Telix mode and enter the command !RFLT. All four channels should have 2-10 volts on all wavelengths. If any are less than 2 volts consult with the manufacturer. **(Never adjust trim pots on the Coprocessor PCB to achieve the proper voltages.)**

4.5.2 Lamp Replacement

The lamps should not be handled with bare hands. Any oil from your hands will cause the lamp to burnout and fail. Install the new lamp in the place of the bad lamp. You will have to trim the wires of the lamp to make it fit. Match the bend of the other lamps. Next you will have to align the lamp. The tip of the bulb should point straight down. The light should project straight into the photometer. Retest the voltage using the !RFLT command.

A lamp should be replaced only if it fails to light. Contact your distributor if filter voltages are reported as low.

Materials and equipment:

- Replacement lamp
- Phillips screw driver
- Flat blade screw driver

Procedure:

1. Set the power switch to OFF (O). Open the instrument, refer to Figure #4.5, and open the lamp cover

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CAUTION

Lamp is HOT. Allow the lamp to cool before handling.

2. Refer to Figure #4.5.2 a and b, Lamp Replacement. Loosen but do not remove the lamp terminal screws. Do not loosen or remove any other screws. Remove the lamp by lowering it out of the connector.

3. Use a pair of pliers or tweezers to handle the new lamp. Avoid handling with bare skin, since the oil from your skin can reduce lamp life. Insert the lamp leads into the connector until they bottom out. The lamp lens end must be centered on the aperture and the lamp body must be perpendicular to the horizontal. While holding the lamp in alignment, tighten the lamp terminal screws.

4. Set the power switch to ON. Shield your eyes from the lamp beam and observe the projection of the beam onto the aperture. Refer to Figure #4.5.2b, Spot Alignment. The spot should be small and centered on the aperture. The spot should be sufficiently large to just encircle the aperture. If the spot is not centered, repeat step 3.

5. Select test !RFLT. The instrument reports the detected voltage for each filter position. All voltages should be between 2.00 volts and 10.00 volts. If all the voltages report low, repeat step 3 until optimum lamp position is obtained.

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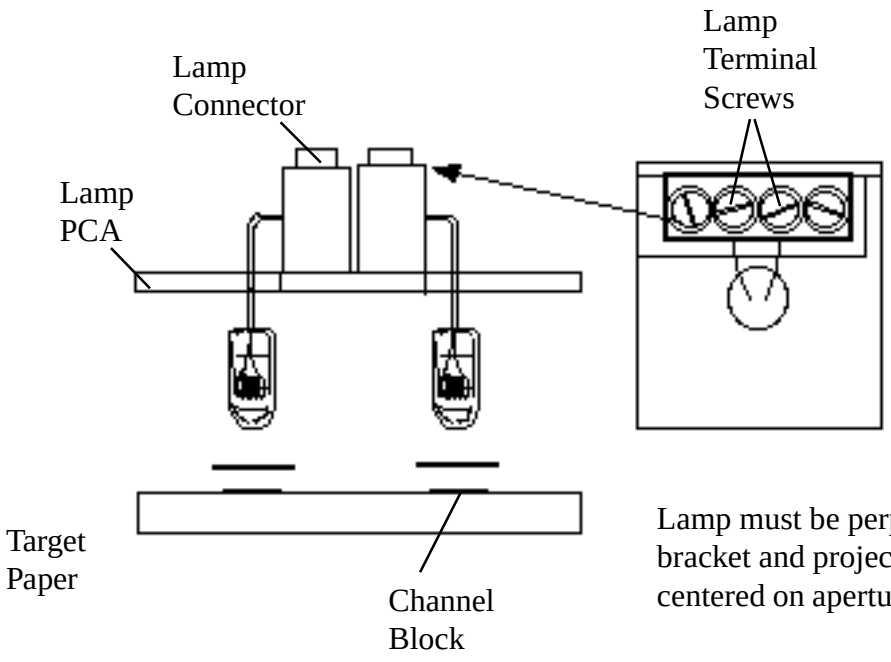

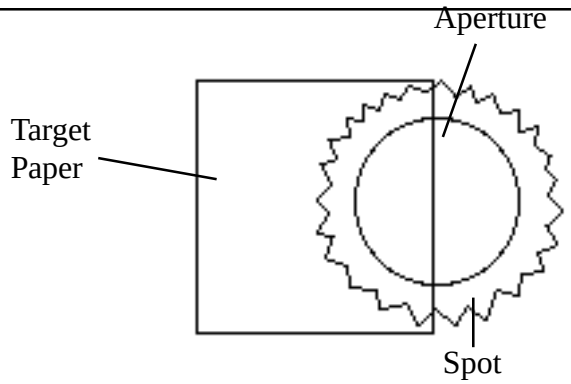
Aperture
Target
Paper
Spot
Projected spot must be bright and slightly larger than aperture hole so the outside edge of the spot does not touch or enter into the hole. The spot should be well defined and centered on aperture. Use a small piece of paper as a target to observe the spot.

Figure #4.5.2b Spot Alignment on Channel Block

4.5.3 Adjust Lamp Bracket Level Screws

Towards the rear of the photometer are two #6 screws which are used for providing additional support and leveling the lamp bracket. These screws should be firmly touching the underside of the lamp bracket. To adjust them, remove the lamp bracket and loosen the hex nut at the leveling screw base and turn the screw the necessary number of turns to level or provide support for the lamp bracket. Retighten the hex nut when finished.

4.5.4 Exhaust Fan

To control the amount of heat generated by the four xenon lamps of the photometer, the lamp housing of the photometer is coupled to a fan located to the right of the machine by a 10" length of corrugated PVC tubing. The tubing is held in place at the end by fitting a corrugated ridge into the fan coupling and may be released by pulling it free. Should the lamp housing need to be removed, release the tubing

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from the ChemWell at the fan coupling in the rear first. When replacing the lamp cover, seat the cover on the lamp bracket taking care to route the red lamp power wires through the exit notch in the housing. Replace the tube in the fan coupling by pressing one of the tube's ridges through the hole in the coupling until it "snaps" into place. Do not press more than one ridge through, as that may interfere with the motion of the exhaust fan. The lamp housing, when properly ventilated, will remain slightly warm to the touch.

4.6 Photometer - Assembly Placement

4.6.1 Adjust Photometer

Lamp Alignment

To align a lamp, make sure the ChemWell is powered on. Move the plate carrier bed 2" to the right by giving a !PLXM0200 command in the telix mode window of the control software. Turn the self homing feature off by issuing a !IOFF command. If the lamps are off at this point turn them back on by issuing an !LPON command. Insert a white piece of paper on top of the channel block underneath the aperture block of the lamp bracket. You will see four white elliptically shaped spots. Adjust the spot of the lamp by raising or lowering the lamp with a pair of needle nose pliers, taking care not to short the leads, until it is in focus and centered over the channel block hole. You may need to slightly rotate the lamp as well. Remove the paper and check the filter voltages by executing an !RFLT command. Repeat the procedure until the voltages are in the acceptable range and replace the lamp cover. Refer to figure 4.5.2.

4.6.2 Photometer Mount and Adjustment

The photometer assembly is retained in a mount assembly by a 4" long 10-32 pin. The photometer is designed to be removed by first unscrewing the retaining pin, disconnecting the cables from the photometer junction board, and then sliding the photometer assembly out of the mount and through the right side of the machine, see figure 4.7.2. The mount assembly serves to provide a fixed reference platform for the photometer with respect to the plate carrier assembly. To adjust this position, loosen the two #8 machine screws at the rear of the photometer and position the photometer as necessary. Avoid making large adjustments. The photometer mount assembly should only be adjusted if precise alignment of the plate carrier with respect to the photometer cannot be achieved by displacing the carrier along the X and Y axis.

For alignment with Plate Carrier travel see "Alignment- Photometer" and "Alignment- Plate Carrier" to complete photometer placement.

4.7 Filter Wheel

4.7.1 Filter Label

The filter label located on the lamp bracket describes the specific filter wheel configuration for your particular instrument. Refer to Figure #4.7.1b.

Filter wheel position is the physical placement of the filter on the wheel. The filter wheel position numbers are shown in Figure #4.7.1a. Note the position of the Index hole and the Home hole.

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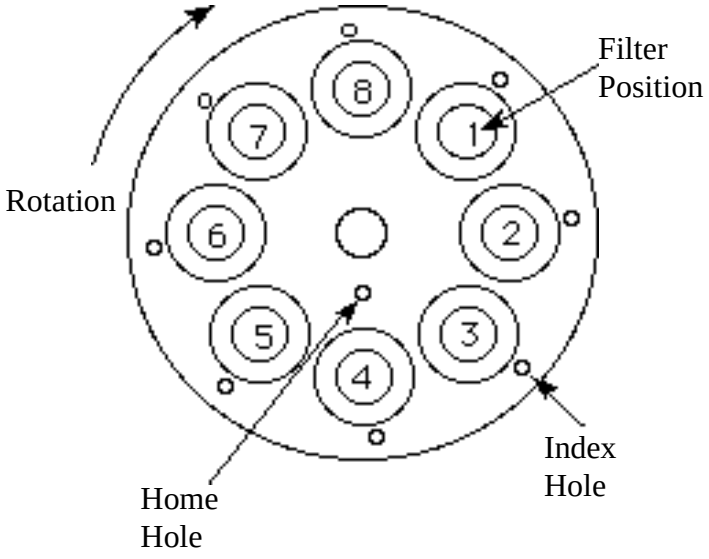

Figure #4.7.1a Filter Wheel Postions

Filter Wheel Part # 996040				
Position	Filter	Position	Filter	
1	340	5	505	Filter Wheel
2	700	6	545	No.
3	405	7	600	_____
4	450	8	630	

Figure #4 7.1b. Filter Label

4.7.2 Photometer Filter Replacement

Materials/tools required:

Replacement filter set
1- Phillips screw driver
1- Flat blade screw driver
1- sharp pick or pointed object

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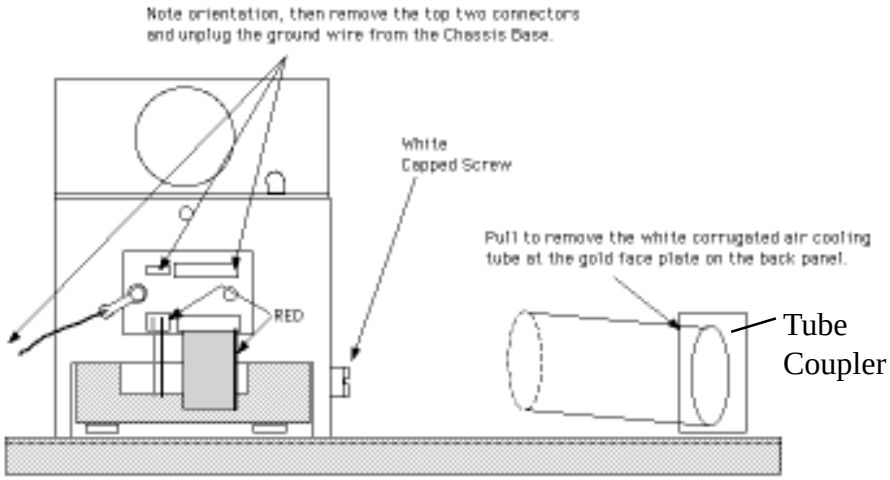
Note orientation, then remove the top two connectors
and unplug the ground wire from the Chassis Base.
White
Capped Screw
Pull to remove the white corrugated air cooling
tube at the gold face plate on the back panel.
RED
Tube
Coupler

Figure #4.7.2 Photometer Diagram

Step 1:
Disconnect the instrument from the AC mains and detach the power cord. Disconnect bottles. Remove the right side cover. Set the cover out of the way.

Step 2:
Refer to figures #1.3.1 and #4.5. Locate the photometer. Note the location of the red marking for cable orientation before removing connector. Note the orientation of the harness cable and connector from the coprocessor board. Unplug the two upper cables from the photometer junction PCB. Leave all other connections on this PCB alone. Unplug the ground wire at the red quick disconnect terminator located at the chassis end of the ground wire. Leave the two individual RED wires going to the lamp assembly attached. Remove the white corrugated air tube by pulling it from the gold colored tube coupler plate located on the instrument's back panel.

Step 3:
Locate the (white) slotted cap screw retaining the photometer to its mount. Turn the cap screw until you can remove the threaded shaft. Remove the photometer by sliding it out the side. **Note: DO NOT REMOVE THE RED LAMP WIRES from the photometer. Removing or altering other parts of the photometer will require the unit be realigned. Do not move the lamp or the lamp bracket**.

Step 4:
Turn the photometer over so the three screw heads are facing up. Remove the (3) 6-32 screws retaining the photometer cover. Set the photometer cover aside. Remove the (4) 4-40 screws securing the photometer PCB. Hang the PCB to the side.

Note: Do not touch the components on the PCB especially the photo diodes and their windows. Do not let the filters get dirty, dusty, or contaminated. Note the orientation and position and in the case of filters, the wavelength of anything removed.

Remove the drive belt from the filter wheel. Using the blade screwdriver, loosen the filter wheel shaft.

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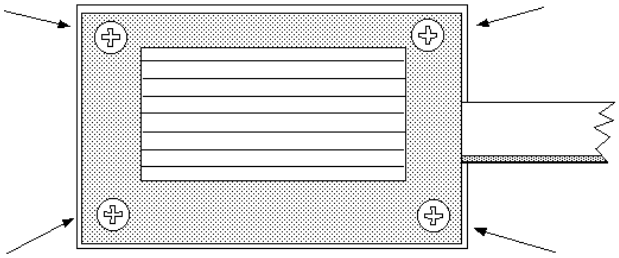
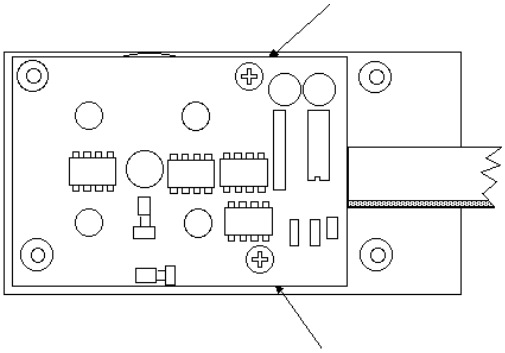
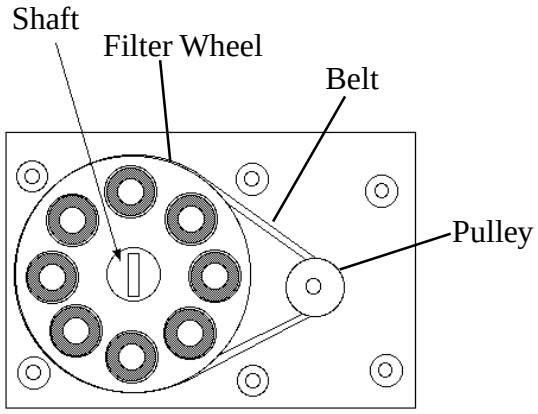


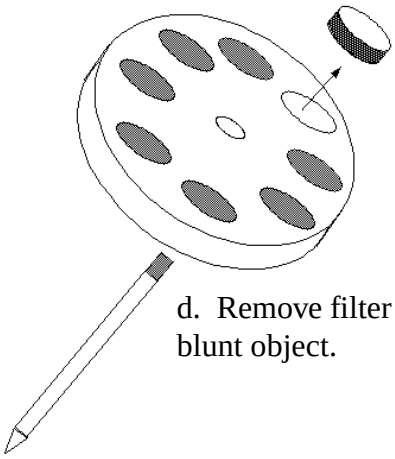
a. Remove screws holding photometer cover.



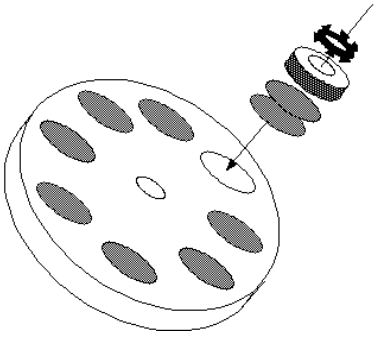
b. Remove screws holding photometer PCB.



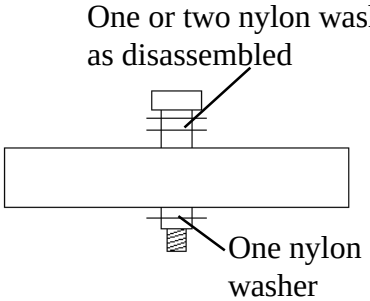
c. Remove filter wheel belt and filter wheel. Rotation is clockwise.



d. Remove filter with blunt object.



e. Install neutral density filters, dot screens, and interference filters.



f. Assemble washers and filter wheel to filter wheel shaft.

Figure #4.7.2b Photometer Filter Change

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Make notes of orientation of parts and their positions. Remove the wheel. Remove the shaft taking care not to misplace the nylon washers.

Step 5:
Referring to Figure #4.7.1. Locate the filter to be removed. The filters are fixed by use of a retaining ring. Use a pointed object to get under the tabs of the retaining ring. Pry two or three of the tabs (teeth) away from the filter until the ring is dislodged and remove the ring and filter. The filter may be bumped or pushed from the wheel using the eraser end of a pencil or other blunt object. Remove any remaining filter components from the filter cavity.

Locate then install the neutral filters and/or screens if any that were included with the replacement filter (some wavelengths do not require these extra screens) and place them into the wheel cavity first. Next insert the filter with the flat ring side down. Place the replacement retainer ring over the filter so the tabs are angled away from the filter (up) and press ring in place with a 7/16 inch or 11mm wooden dowel or similar tool.

Step 6:
Installation of the photometer is the reverse of disassembly. Reinstall the filter wheel on the bracket taking care not to pinch any washer under the shaft. Make sure no molding dimples from the washers are against the filter wheel. Check the lube to see if it is dry, dirty, or missing. Add more lube if needed. Tighten the shaft. Be sure that the belt is centered on the filter wheel and is not twisted. Install the photometer PCB taking care to center the large hole around the shaft.
Replace the optical cover taking care to fit and position the gray cable in the slot of the cover. Do not pinch the cable under the cover or it will be cut off. Insert the (3) 6-32 screws and snug up. Do not overtighten the photometer cover screws! Doing so will bend the photometer cover and create light leakage.

Step 7:
If the lamps were disturbed during the above operations. Check that the lamps hang vertically down and are aimed at the screen and aperture holes. If necessary refer to the lamp alignment procedure in the service manual.

Step 8:
Replace the side cover.

Step 9:
Attach the power cord and connect the unit to the mains supply. Turn the unit on. Send command !RFLT. The displayed numbers represent the voltages of the installed filters. All voltages should be between 2 and 10 volts.

Fill plate wells A1, A4, D1, D4 with water treated with surfactant to create a curved meniscus on the water surface. Install this plate and send command !BLNKA01 to establish new blank levels.

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4.8 Plate Carrier

The ChemWell plate carrier is designed to be able to be removed for service from the plate mover assembly. In the rare event that it becomes necessary to remove the plate carrier, use a 1/16" hex key to remove the set screw retaining the 1/4" stainless steel guide rod. Pull the guide rod out through the front of the instrument. Cut away the tie wraps anchoring the orange and violet cable of the plate carrier, and unplug the cable from the plate mover junction board. The plate carrier is now free to be removed. Replace the plate carrier by reversing the above mentioned steps. Extra tie wraps of the type used for routing the cable have been enclosed in the ChemWell service parts pack. The cable should be routed making sure to have a small service loop of about 6" - 7" for plate travel. Check the plate carrier's temperature calibration as per the instructions given in 5.4 Calibration- Plate Carrier.

When installed, go to Alignment- Plate Carrier.

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4.9 Hydraulic System

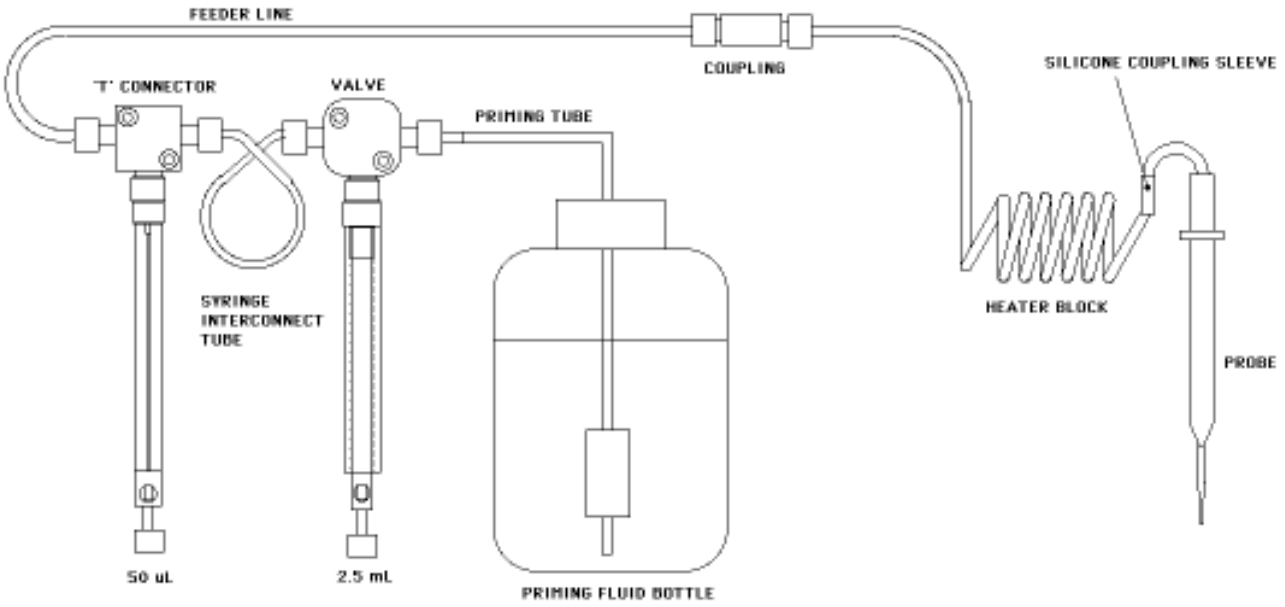

Figure # 4.9 Hydraulic System Diagram

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4.9.1 Syringe Pump

To replace the syringe pump:

1) Unscrew the feeder line fitting from the ‘T’ connector.
2) Remove the ChemWell prime bottle & prime tube by unscrewing the fitting to the valve and set the prime bottle aside.
3) Remove the four 6-32 truss head screws retaining the syringe pump assembly. (See Figure 4.9.2)
4) Making sure the power to the ChemWell is OFF, pull the syringe pump assembly panel forward.
5) In the back of the pump assembly, unplug the blue ribbon cable connector and the yellow power connector.
6) The syringe pump module can now be lifted from the chassis.
7) Install new syringe pump by reversing steps 6-3.
8) Remove Syringes (see procedure), ‘T’ connector and Valve from the old pump and transfer to the new one using the 3/32" hex key supplied in the ChemWell tool kit to remove the four metric socket head screws retaining the ‘T’ connector and valve.

4.9.2 Syringe Replacement

The 2.5 mL and 50 uL syringes are luer-lock type, and are retained by a nylon set screw at the base of the syringe. To remove a syringe, first loosen the thumb screw at the base and then rotate the syringe in a clockwise direction to loosen the syringe from its luer fitting. When replacing a syringe, make sure that the thumb screw is tight and that the syringe is firmly seated onto its luer fitting by rotating the syringe counter clockwise until it can no longer be turned without great effort. Periodically check to make sure that the syringes are tightly held, as any looseness or backlash will effect the results of the pipetting. **Do not remove and clean plunger of syringe.** Doing so will require replacement of entire syringe.

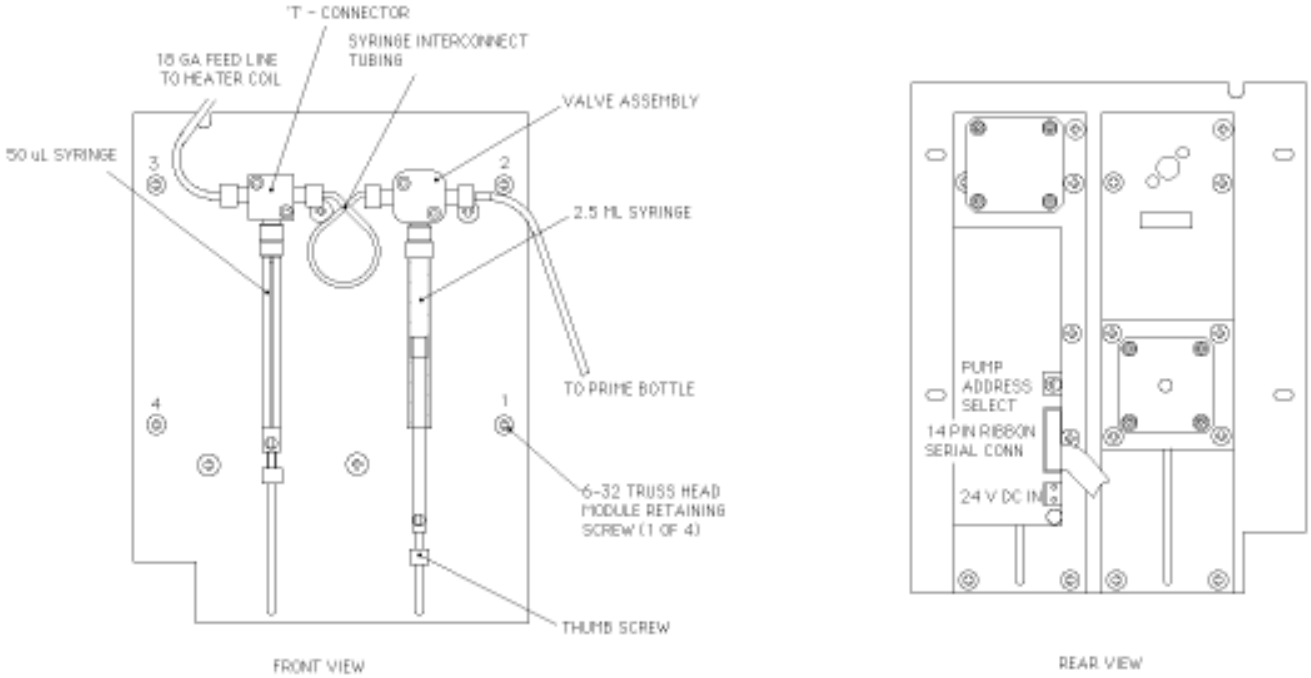

Figure # 4.9.2 Syringe Pump Diagram

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4.9.3 Fittings— Tubing, fittings, etc.

ChemWell tubing is 18 GA standard wall TFE for the feeder and syringe interconnect lines. Fittings are 1/4-28 and are made of Delrin. Tubing is flared at the ends and an o-ring is used with the fitting to compress against the flare to make a water/airtight seal. Never overtighten the fittings- this could damage the seat of the valve or strip the threads of the fitting or 'T' connector and cause an air leak. Fittings should be tightened by hand only. Should the tubing become excessively kinked, or the o-ring or fitting becomes damaged, it will need to be replaced.

4.9.4 Repair Tubing

The general procedure for replacing the tubing is as follows:

1) Cut the length of tubing necessary for the job: Feeder Line: 18 GA SW TFE: 3.5 feet (1.07 meters), syringe interconnect: 18 GA SW TFE: 8 inches (20.32 cm). Cut this tubing evenly with a sharp knife.

2) Remove old tubing. For the syringe interconnect tube, unscrew the fittings from the valve and T connectors at both ends. For the feeder line, unscrew the tube fittings at both ends, and cut the fittings off. Leave the old cut tube in place for now. Flare the tubing at the 'T' connector end so that the new tubing can sleeve inside. Sleeve the new feeder tubing inside the old tubing and pull the new tubing through the cable carrier by pulling the old tubing at the probe mover end. When the new tubing passes through the cable carrier, discard the old tubing leaving the new tubing in place.

3) Install the Delrin fittings at each end first, followed by the washer and then the o-ring. Use the o-ring to hold the fitting in place a few inches away from the tubing ends.

4) Using a flaring tool, make a flare at each end of the tube. The flare should be concentric with respect to the tubing ID and have an outer diameter of ~0.15" (3.81 mm)

5) Pull the fitting/washer/o-ring combination forward to the flare, the tubing replacement is completed.

6) Screw the fittings back into place and route the tubing through the tubing clips. Prime the system, making sure all air is cleared and there are no leaks.

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4.10 Valve and Pressure Pump

Anatomy

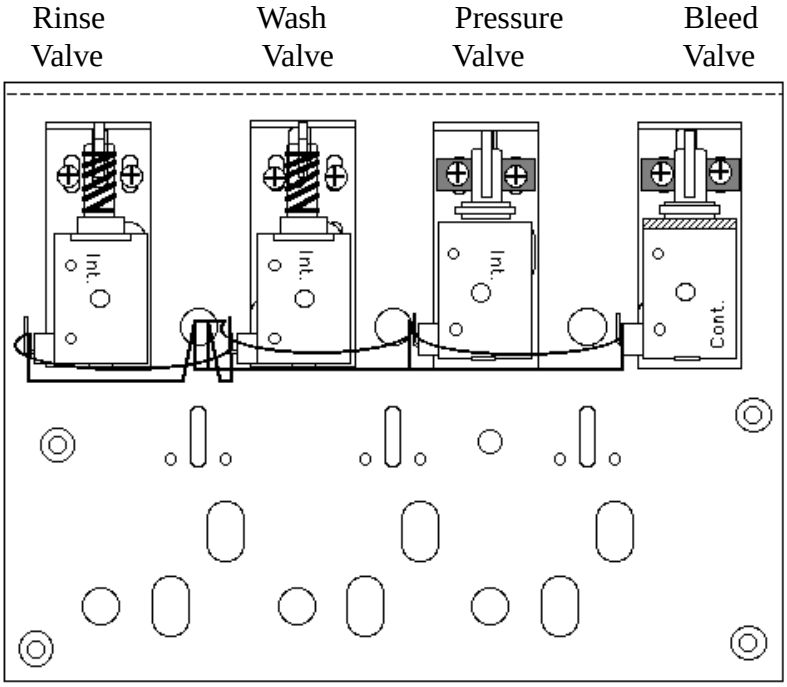

Figure # 4.10 Valve and Pressure Diagram

4.10.1 Valve Tubing Replacement

The silicone tubing used in the valves may become clogged or worn with age. If this occurs, the tubing should be unstuck, cleaned, or replaced. Try holding the valve open and pull the tubing to reposition the clamping to another section of tubing.

To replace tubing:

1. Set the power switch to OFF (O).

2. Refer to Figure #4.10. Locate the valve to be serviced.

3. Note the relevent end connections and location of the tubing within the valve.

4. Refer to Figure 4.10.1a and 4.10.1b. Pull back the pinch bracket and remove the valve tubing from the valve body.

5. Disconnect the valve tubing from the fittings at both ends.

6. Cut the replacement tubing to match the length of the original.

7. Install the replacement tubing to the valve body. Push the tubing over the fittings until seated. If you have trouble sliding the tubing over the fittings, dip ends of tubing in isopropyl alcohol. Be

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especially careful not to kink, stretch, or tension the tubing. The replacement tubing should be routed in exactly the same place as the original.

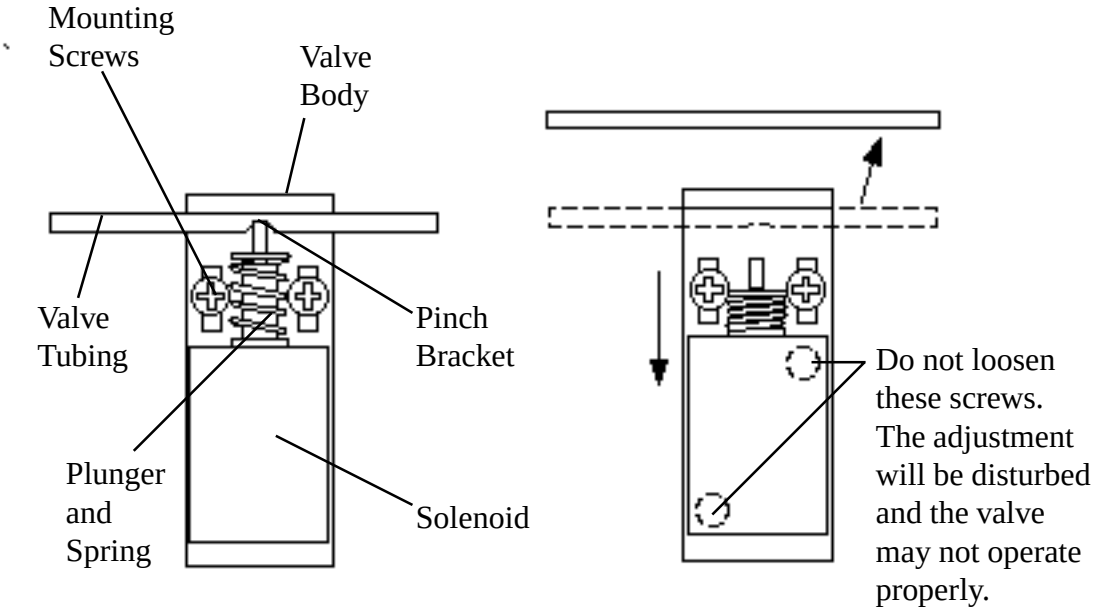
Mounting Screws
Valve Body
Valve Tubing
Pinch Bracket
Plunger and Spring
Solenoid
Do not loosen these screws. The adjustment will be disturbed and the valve may not operate properly.

Figure #4.10.1a Wash and Rinse Dispense Valve Tubing Replacement

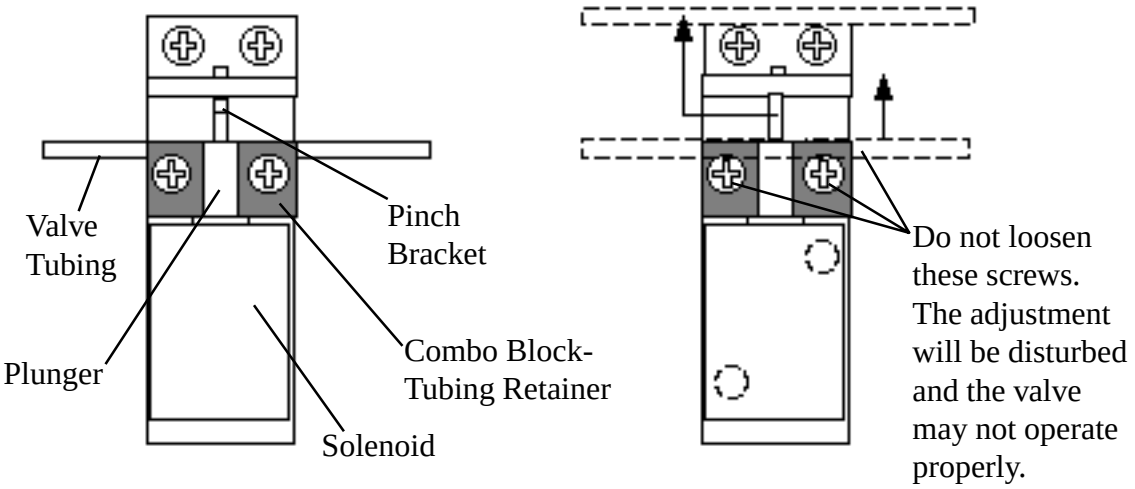
Valve Tubing
Pinch Bracket
Plunger
Combo Block- Tubing Retainer
Solenoid
Do not loosen these screws. The adjustment will be disturbed and the valve may not operate properly.

Figure #4.10.1b Bleed and Control Valve Tubing Replacement

4.10.2 Wash Dispense and Rinse Dispense Valve Replacement

1. Set the power to OFF (0).

2. Refer to Figure 1.3.12, 4.10, and 4.10.1a. Locate tubing and valve of interest in diagrams. Note where valve tubing make connection with fittings just above the valve and disconnect tubing.

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3. Remove dispense valve mounting screws from the valve needing replacement.

4. Unsolder the wiring from the original solenoid and resolder to the replacement solenoid.

5. Install replacement valve by installing the mounting screws.

6. Cut the replacement tubing to fit.

Replacement valves are preadjusted and do not need further adjustment.

7. Reconnect the tubing to fittings. Push the tubing over the fittings until seated. Be especially careful not to kink, stretch, or tension the tubing. The replacement tubing should be routed in exactly the same place as the original.

4.10.3 Bleed or Control Valve Replacement

Note: Bleed valve must be continuous duty type solenoid and will be marked "CONT.".

1. Set the power switch to OFF (O).

2. Refer to Figure 1.3.12, 4.10, and 4.10.1a. Locate tubing and valve of interest in diagrams. Note where valve tubing make connection with fittings just above the valve and disconnect tubing.

3. Hold the solenoid plunger away from the valve tubing as indicated by arrow and remove the tubing by pulling through opening.

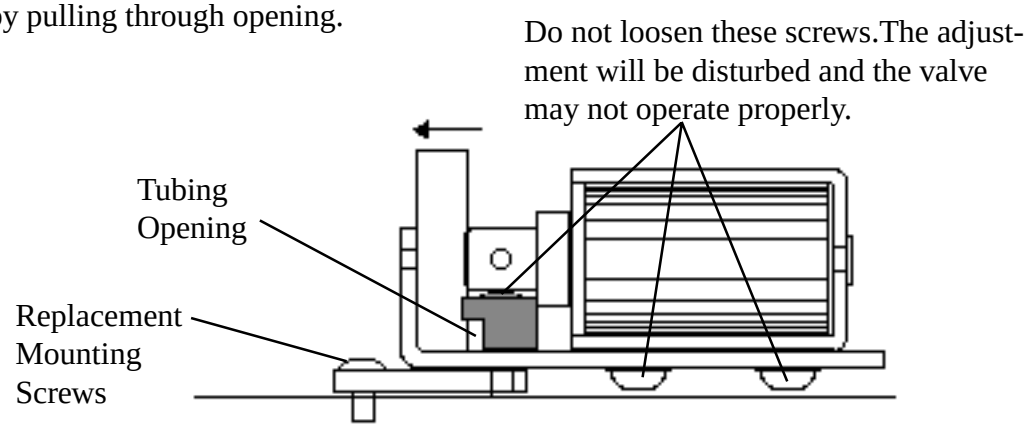
Do not loosen these screws.The adjustment will be disturbed and the valve may not operate properly.
Tubing Opening
Replacement Mounting Screws

Figure #4.10.3 Replacement Bleed Valve Mounting

4. Remove the two screws which secure the defective valve. Replace with new valve assembly by securing the assembly with the two supplied replacement mounting screws and lock washers. Replacement valves are preadjusted and do not need further adjustment.

5. Cut the replacement tubing to fit.

6. Hold the solenoid plunger away from the valve bracket and insert the tubing between the plunger and the bracket while routing the tubing through the holding slots in the valve bracket.

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7. Reconnect the tubing to fittings. Push the tubing over the fittings until seated. Be especially careful not to kink, stretch, or tension the tubing. The replacement tubing should be routed in exactly the same place as the original.

4.11 Washer

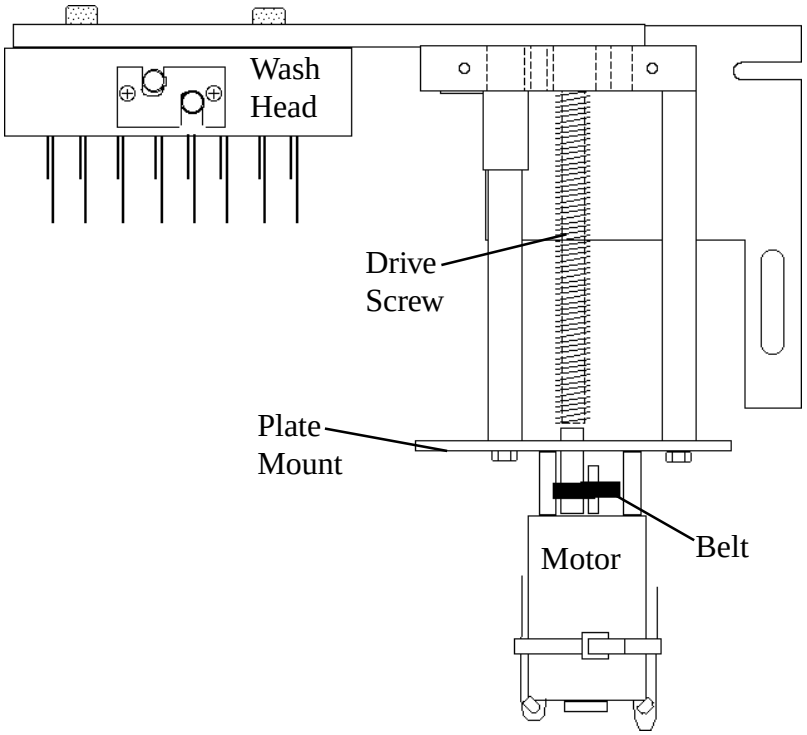

Figure #4.11 Washer Diagram

Clogged Head
See Incomplete Aspirate or Dispense.

Clogged Tubing
Take tubing between fingers and massage material loose. If needed, gently exercise tubing till clog is released. If you are unable to release material, see tubing replacement.

Noisy Drive Screw
If you have an aluminum drive screw rod, it will squeak loudly if it needs lubrication. Apply a small amount of lubrication gel included.

The neoprene drive belt which couples the probe motor to the probe lead screw pulley can become worn or loosen with age.

Remove the four flat head screws at each corner of the plate mount. Lift the plate mounting upward

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and forward to clear the probe arm.

Look at the bottom of the mechanism assembly. Remove the old belt by carefully lifting one side off the probe motor pulley. Remove the belt from the other pulley. Do not bend the optical sensors mounted on the edge of the mechanism PCB.
Install the new belt first to the probe lead screw pulley, then to the probe motor pulley. Do not bend the optical sensors mounted on the mechanism PCB. Do not twist the belt.

Turn the probe motor shaft several revolutions to ensure that the belt is seated without twisting.

Install the mechanism assembly and replace the four nuts.

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5.0 Calibration

CAUTION: ANY INSTABILITY OF CALIBRATION COULD INDICATE AN INSTRUMENT PROBLEM. DO NOT RECALIBRATE ANYTHING WITHOUT CONSIDERING ALL OTHER ALTERNATIVES.

5.1 Setup

See Alignment section of this manual.

5.2 Photometer

If you feel that the photometer needs calibrating, call the manufacturer.

5.3 External Sensor

There is an external sensor (External Temp. Probe) located on the electronics rack, to the front, right side. Plug in the 37°C Reference (comes in distributor pack). In Telix mode, send a !STAT command, then see if Ext in the status window reports 37°C+/- 0.2°C. If not, adjust the external temp pot (Daughter Board R23) and repeat. See caution at the top of the section.

5.4 Plate Carrier

Dispense 200µl water in all wells. Place a plate of strips in the metal plate insert in the plate carrier and plug thermistor probe (comes with distributor pack) in the External Probe Sensor jack. Place thermistor probe in well at the center of the plate in center of fluid in the well, tape down. Close all lids and covers and let equilibrate. Type !STAT. Compare Ext: with Plt: (plate). Measurements should be within +/- 0.2°C. If not, adjust plate temp pot, Daughter R28, and repeat. See caution at the top of the section.

5.5 Coil/Block

Plug thermistor probe (comes with distributor pack) in External Probe Sensor jack. Insert thermistor in the hole front and center of the block. Compare Ext: with Coil:. Measurements should be within 37°C +/- 0.2° C. If not, adjust coil temperature pot on the Probe Sensor and Heater Control PCA R23. See caution at the top of the section.

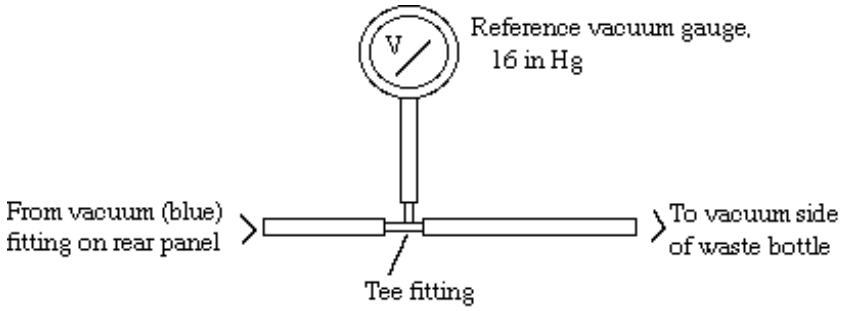

Figure #5.6 Gauge Connections- Vacuum Calibration

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5.6 Vacuum

Attach a vacuum gauge to the blue fitting on the right side of ChemWell. Type !VAON to turn vacuum on, then type !STAT. Vacuum and gauge should agree. If not, adjust pot (Daughter R9) until agreement. See caution at the top of the section.

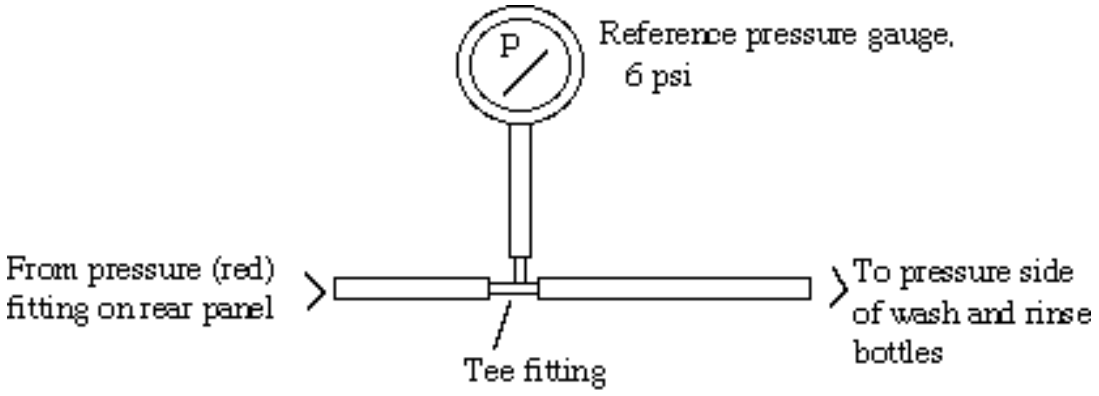
P
Reference pressure gauge, 6 psi
From pressure (red) fitting on rear panel
To pressure side of wash and rinse bottles
Tee fitting

Figure #5.7 Gauge Connections- Pressure Calibration

5.7 Pressure

Attach a pressure gauge to the red fitting on the right side of ChemWell. Type !PRON to turn on pressure and wait for pressure to be reached. Pressure should be at 5psi. If not, adjust the pressure trimpot (Daughter R10) until pressures agree. See caution at the top of the section.

5.8 Trimpots on Daughter PCA

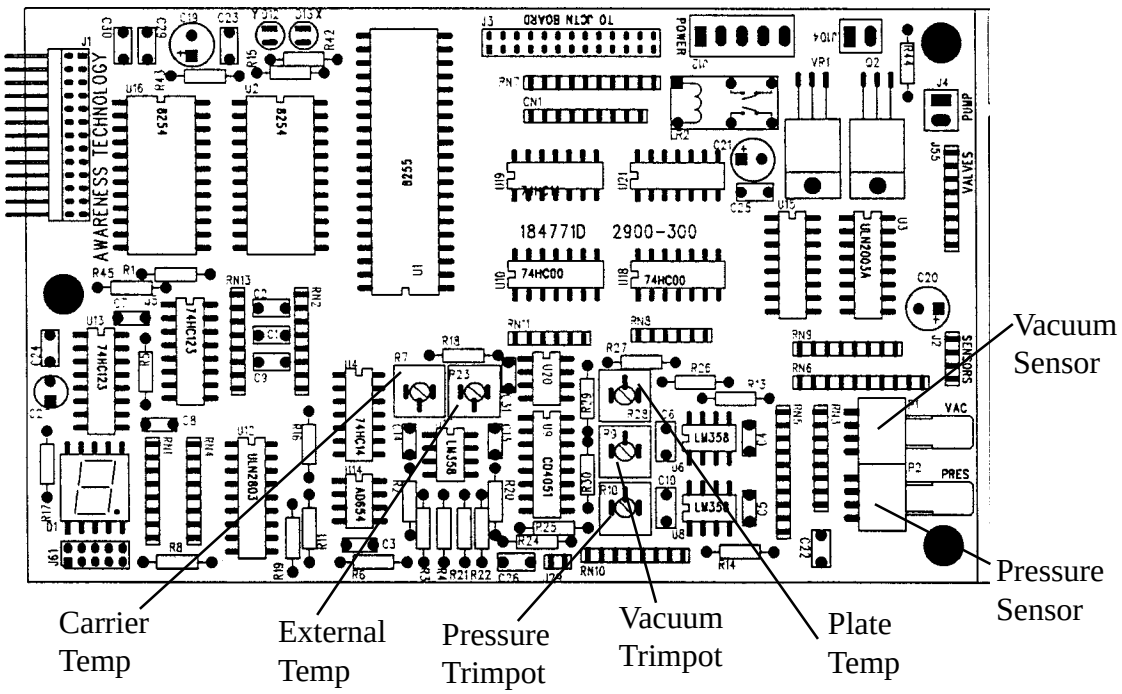

Figure #5.8 Trimpot Locations on Daughter Board

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6.0 Alignment

6.1 Photometer/Plate Carrier

This is only required to verify if you suspect that your instrument is having trouble reading (e.g., poor repeatability on reading), or if you move the X-home or Y-home flags.

1. Alignment Check

Remove the aerosol shield, probe shield, and lamp housing cover. Lift the instrument hood. Taking care not to disturb the lamps, release the lamp bracket by removing the 8-32 retaining screw. Rotate the lamp bracket 90 degrees clockwise and screw the lamp bracket back down. This will keep the lamp bracket in a position out of the way, allowing you to see the position of the plate carrier with respect to the photometer.

Place the metal carrier in the metal plate insert into the plate carrier, and enter a read-well command for position A1 (e.g., !RWELA01723B). Look straight down at the holes in the channel block while the read command is occurring, and the holes of the channel block should be centered in the holes of the plate insert. Repeat with position H12 (opposite sides of the plate, command !RWELH12723B) . Refer to section 3.1.9 Photometer Commands

2. Alignment Procedure

To compensate for backlash, the plate carrier assembly is fitted with a set of index plates to reference the plate position with respect to the photometer. If the instrument is out of alignment, you will need to adjust the index plates.

Caution: Alignment of the plate carrier to the four separate channels of the photometer is critical for accurate absorbance measurements to occur and must before done after aligning the photometer. Reblank after aligning the photometerby using the !BLNKA01 command.

To adjust the aligment, select under the script window the script ‘Align.1st’. This script consists of a large series of the same command ‘!RWELA01721’. While this script is running, observe the centering of the (4) photometer aperatures in the plate carrier by viewing from above. The carrier should position such that the aperatures are in the centers of the 4 selected well positions. If this positioning is not centered adjust in turn each axis of movement by repositioning the index brackets. The ‘x’ index is located at the right side of the plate mover mechanism. The ‘y’ is attached to the plate carrier. Once centering is achieved type the command ‘YREF”. This will re-establish the location of the ‘y’ index plate. Next type ‘RWELA01721’ followed immediately by ‘!POSI’. This will display the coordinates in the status window of well ‘A01’. Write these down. Next type ‘PARM4Xxxxx’ where ‘xxxx’ is the plx parameter taken from the status window. Next enter ‘ply’ parameter using the command ‘!PARM4Yyyyy’. You have now established the center point of the index bracket search windows. These parameters will be used to determine the search range before a ‘x’ and ‘y’ slot error is generated in the event the index slot is not detected.

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6.2 Rack 1/Rack2

Aligning the racks:

Select either “Align Rack 1” or “Align Rack 2” from the Instrument Setup dialog. When prompted, remove the rack and select OK. The probe will move to the alignment point on the rack as shown (above right). Use the arrow buttons in the setup dialog to move the probe and racks. The double arrows move a large distance, and the single arrows will move a smaller distance. The red arrows will move the rack in and out of the instrument, the blue arrows move the probe left and right, and the green arrows move the probe up and down. When you move either the rack or the probe the instrument will automatically raise the probe. To lower it again use the button showing the probe being lowered. Click “Done” to save the new setting, or “Cancel” to keep the old one.

6.3 Dispense

Aligning the dispense position:

Select “Align Dispense” from the Instrument Setup dialog. Insert a plate or strip tray into ChemWell when prompted then select OK. The probe will move to well H01 and lower into the well. The probe tip should be roughly centered in the well and touching the bottom. Use the arrow buttons in the setup dialog to move the probe position if necessary. The double arrows move a large distance, and the single arrows will move a smaller distance. The red arrows will move the plate in and out of the instrument, the blue arrows move the probe left and right, and the green arrows move the probe up and down. When you move either the plate or the probe the instrument will automatically raise the probe. To lower it to the bottom of the well again use the button showing the probe being lowered. Click “Done” to save the new setting, or “Cancel” to keep the old one.

6.4 Wash Cup

Aligning the wash cup:

Select “Align Wash Cup” from the Instrument Setup dialog. The probe will move to the center wash position and lower into the cup. The probe tip should be roughly centered in the small, center wash cup, with the tip beneath the surface of the water in the cup. Use the blue arrow buttons to move the probe left and right and the green buttons to move the probe up and down. The double arrow will move a larger distance and the single arrow a smaller distance. When you move the probe left to right the probe will be automatically raised. To lower the probe back into the wash cup, use the button showing the probe being lowered. Click “Done” to save new setting, or “Cancel” to keep the old one.

6.5 Washer

Aligning the washer:

Select “Align Washer” from the Instrument Setup dialog. Insert a plate or strip tray when prompted and select OK. The plate will be moved under the wash head and the wash head will lowered into the wells. Use the arrow buttons to adjust the position of the plate and wash head so that the aspirate Rack 2 needles are centered left to right, toward the back of the wells, and touching the bottoms of the wells. The double arrows will move a large amount, and the single arrows a smaller amount. Use the blue arrows to move the plate left and right, the red arrows to move the plate in and out, and the green arrows to move the wash head up and down. When the plate is moved the wash head will automatically be raised. To lower the wash head back into the plate, use the button showing the wash head being lowered. Click “Done” to save the new setting, or “Cancel” to keep the old one.

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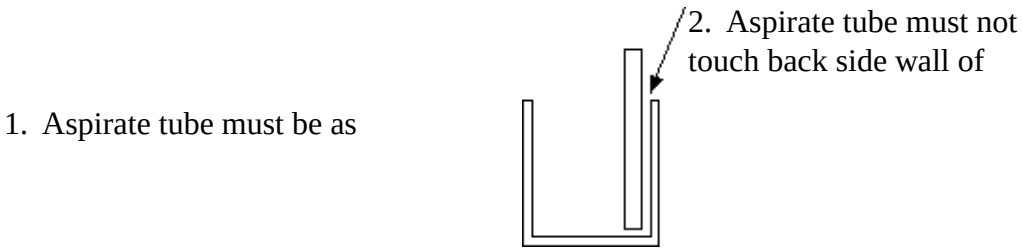

Figure #6.5 Washer Alignment

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Appendix A- Parts

ChemWell® Replacement Parts & Accessories

Description	Part No.
Accessories:	
Laptop Computer	Call
Software Upgrades	Call
UPS - Uninteruptable Power Supply	Call
Belts:	
Belt, Plate X Mover	132050
Belt, Plate Y Mover	132051
Belt, Probe X Mover	132049
Belt, Probe Z Mover	132063
Belt, Rack Y Mover	132064
Belt, Washer	132063
O Ring	132055
Cables:	
Serial Cable- From Computer to Chemwell	104460
Additional Cables	Call
Covers:	
Aerosol shield	990101
Plastic Hinges (set of 2)	188130
ChemWell Hood Label	140210
Heads	
8-way wash head	997420
Plumbing:	
Complete Bottle Set with Sensor Caps and External Tubing for Washer System (Prime Bottle not included)	994011
Bottles:	
Bottle, plastic, 2L, w/sensor cap assy for Waste	994027
Bottle, plastic, 2L, w/sensor cap assy for Wash	994029
Bottle, plastic, 1L, w/sensor cap assy for Rinse	994028
Bottle-Prime	994040
Bottle, plastic, 2L, w/plain cap (Waste or Wash)	187107
Bottle, plastic, 2L, w/plain cap (set of 3)	187107 x 3
Bottle, plastic, 1L, w/plain cap (Rinse)	187104
Waste Carboy with tubing	_____
Pumps:	
Pump (serial #s to 2900-1015) with adapter	105161
Pump (starts at s/n 2900-1016)	105161
Syringe Pump Assembly	994108
Tubing:	
Tubing kit, internal	029___
Tubing Kit	029___
Waste Trough Drain Tube	135201

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Description	Part No.
Valves:	
Bleed Valve Assembly Replacement Kit	029108
Check Valve	137150
Control Valve Assembly Replacement Kit	029107
Valve, Dispense (wash, rinse)	994041
Misc.	
Exhaust filter	137140
Plates:	
Carrier Insert	188171
Plate Carrier Insert Foam 3"	150206
Plate Cover	990113
Printed Circuit Assemblies:	
PCA, Coprocessor (please provide serial number)	995320
PCA, Daughter (please provide serial number)	995330
PCA, DC Junction	995333
PCA, Encoder with Wheel and Reader	_____
PCA, LED Display	995336
PCA, Lamp Junction	995322
PCA, Main (please provide serial number)	995310
PCA, Photometer	995321
PCA, Photometer Junction	995324
PCA, Photometer LED	995323
PCA, Plate Junction	995331
PCA, Power Supply, 12v	101100
PCA, Power Supply, 24v	101101
PCA, Probe Sense and Heater Control	995315
PCA, Probe X Junction	995312
PCA, Probe Z Junction	995313
PCA. Rack Junction	995311
PCA, Relay Junction	995334
PCA, Sensor (Optos)	995314
PCA, Sensor (Opto) With Resistor	995317
Firmware:	
EPROM-Coprocessor (please provide serial number)	163067-Cop
EPROM-Main (please provide serial number)	163067-Main
Racks:	
Rack-Reagent, Large	994115
Rack-Reagent, Square	994111
Rack-Reagent (5 or more ordered at once)	994115
Reagent Bottles (12 per box)	157409
Rack-Sample	994113
Rack-Sample (5 or more ordered at once)	994113
Sample Tubes and Caps	157333, 157335
Custom Racks (specify requirements)	Call

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Description	Part No.
Consumables:	
Blanking Solution 30ml.....	157561
Plate Washing Solution Kit.	157562
Plate Rinse Solution 100ml	157563
PNP Check Set.....	157560
Strips, Box	157202
Strip Tray	157201
Microplate	157203
Chassis light bulbs (set of 2)	112080
Fuse, 3AG 1.5A slow-blow (set of 2)	102003
Lamp, Photometer, Xenon	112007
Syringe 50µl	105184
Syringe 2.5ml	105185
Sampling Probe Assembly	994117
Tools:	
Cable Ties (Qty. 10)	152200
Clean-out Wire, Aspirate	185895
Clean-out Wire, Dispense	185896
Hex Keys (set of 3)	153022, 153023, 153024
Lubrication Gel, 12gm tube	151005
Misc. Replacement Parts:	
Felt	153040
Filter-replacement for originally installed wavelength ("XXX"=nm.)	111XXX
Filter Wheel, 8 position with standard filters installed	996040
Owner's Manual- additional Copy	OM2900
Power Cord- European	137221
Power Cord- U.S., Black	137521
Spare Parts and Tool Kit (2 fuses, hydrophobic filter, 1/16 hex key, clean-out wires, and instructions)	029020
Flangeless fittings	137016

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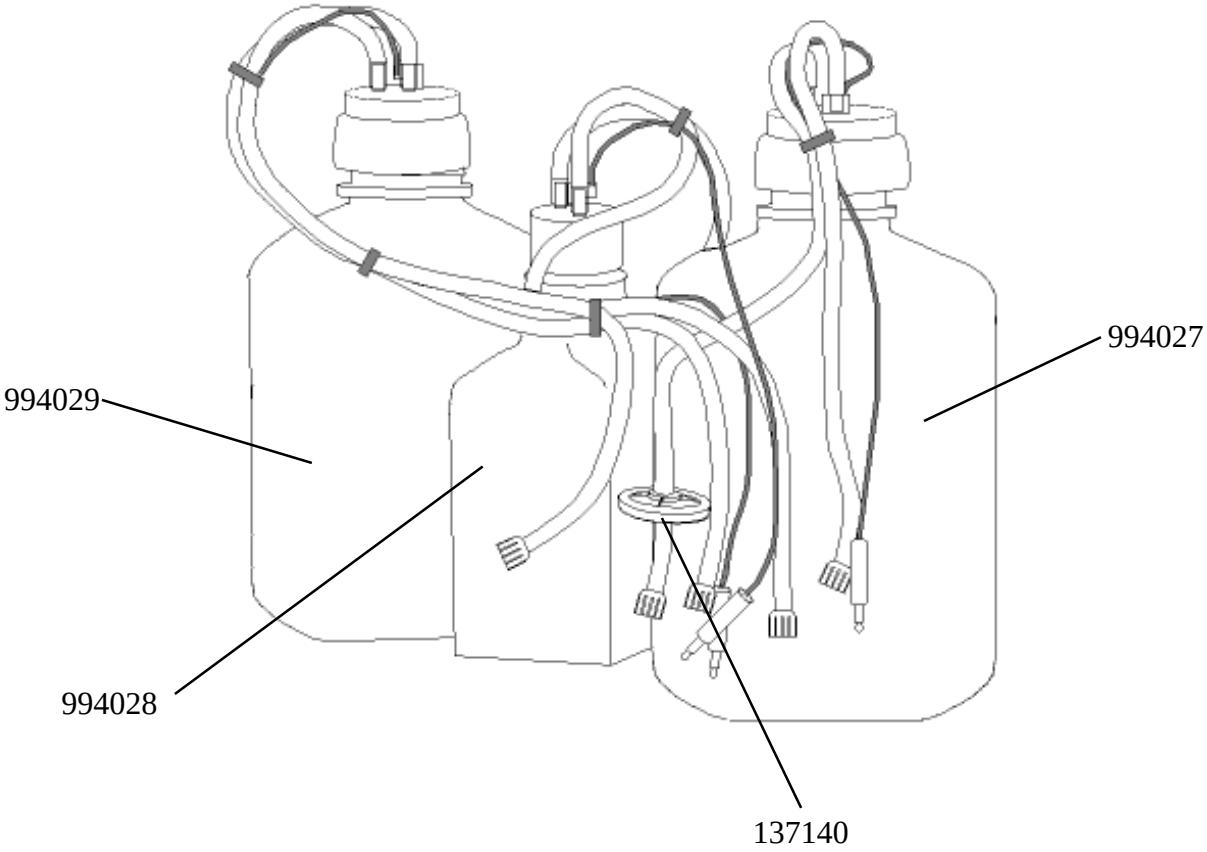
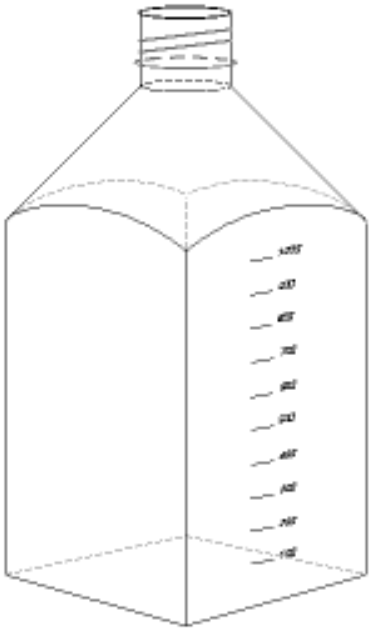
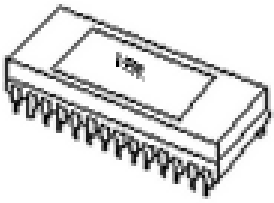
Selected Part Illustrations



994011 Complete Bottle and External Set for Washer System



187104 Prime Bottle



EPROM

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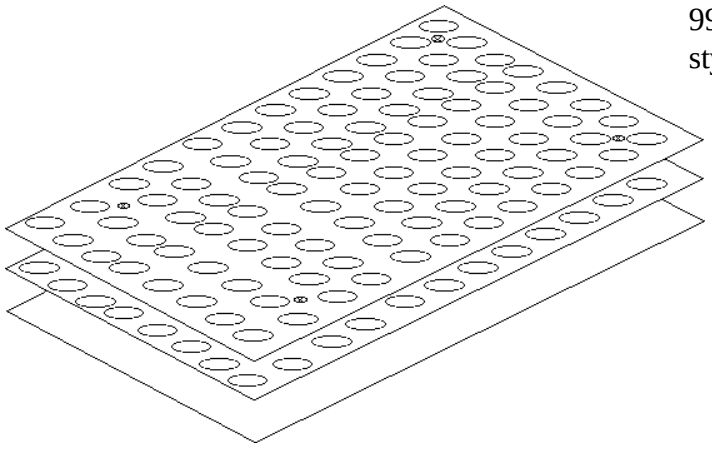
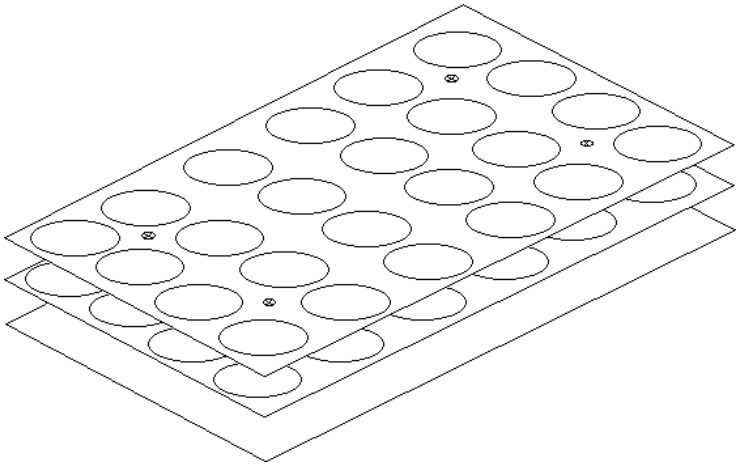
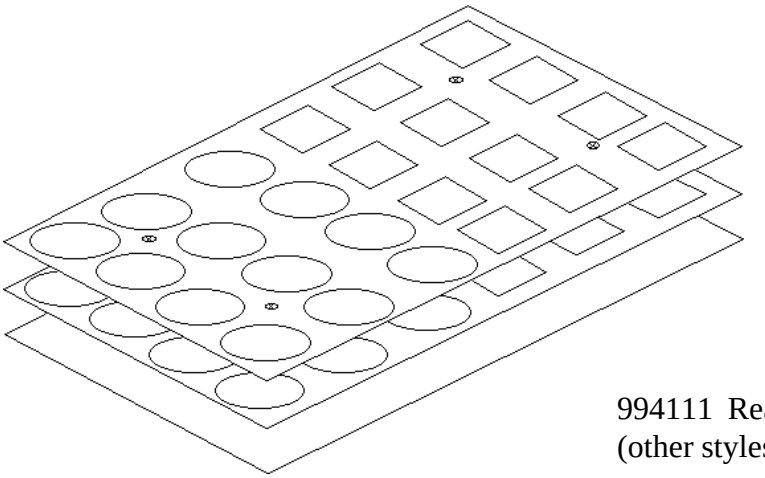


994113 Sample Rack (other styles available)

994115 Large Reagent Rack (other styles available)





994111 Reagent Rack Sq. (other styles available)

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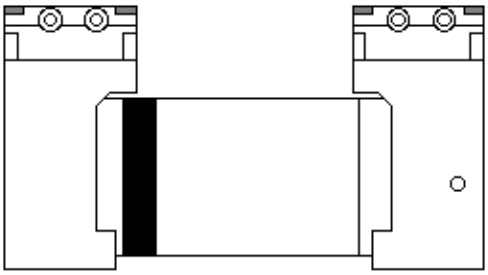
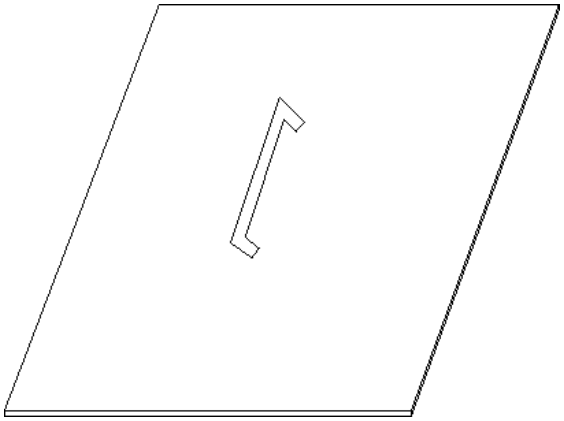
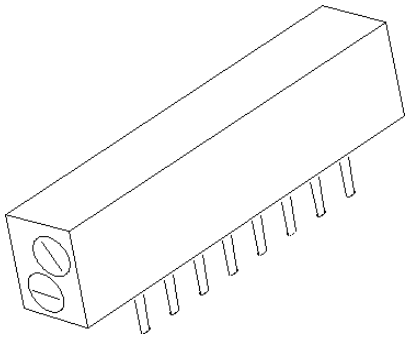


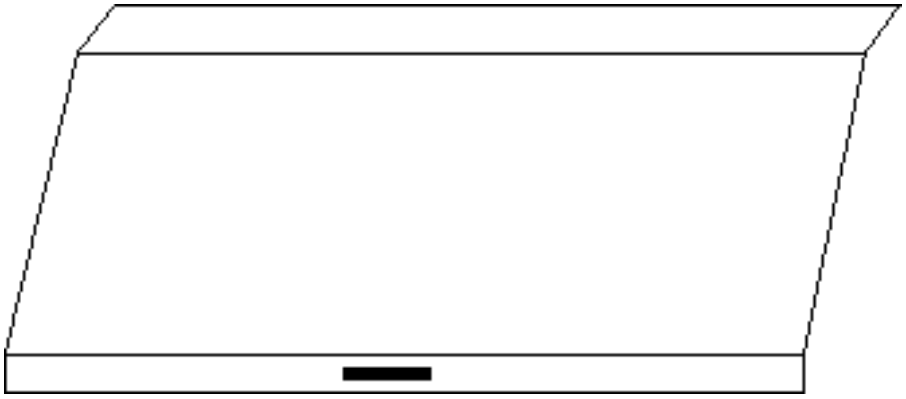
105161 Pump



990113 Plate Cover



997420 8-Way Wash Head



990101 Aerosol Shield

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Model 2900 Luer Fittings
*indicates minimal stock for repairs.

Reference Descriptions (uses)	**Part Number versus Color** White	Black	Blue	Red	Green	Yellow
A. Luer Locking Nut, or Luer Cap	137030*	137027	137028	137029	137026	137025
B. Rotating Luer Lock			137012	137011		
C. Male Luer 1/8 Barb	137122*	137135	137128	137127	137129	137134
D. Luer Coding Rings 137114 137116	137119*	137115	137117		137118	
E. Female Luer Bulkhead 3/32 Barb	137102*	137107	-	-	137106	137105
F. Female Luer Bulkhead 1/8 Barb	137101*	137108	137104	137103	-	-
G UNF Female Luer 10-32 thread large hex	-	-	137126*	137124*	-	-
I. Nut for Bulkhead 1/4-28 Thread	121961					
J. Flat Washer Nylon 1/4 ID	121952					

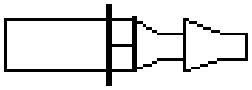
Notes: Barb connections are 1/8 if clear vinyl tubing, 3/32 if silicone tubing.
Reference uses:
A, B, and C are for external tubing (bottles and head.) D, E, G, H, and I are for panel bulk head. G is for the wash head.

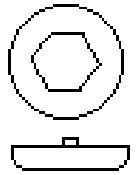
A

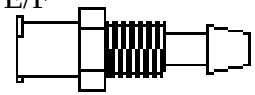
Locking Nut

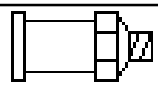
B

Rotating Luer Lock

C

Male Luer

D

Coded Ring

E/F

Female Luer Bulkhead

G

UNF Female Luer

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Parts by Sub-Assembly

Aerosol Shield
Clip, 1/3 tubing with Adhesive 137057

Bottle Set
Luer, male cap, yellow 137025
Luer, male cap, green 137026
Luer, male cap, black 137027
Luer, male cap, blue 137028
Barb, tee, 1/8" 137130
Luer, male, 1/8" barb, black 137135
Filter, hydrophobic 137140

Chassis
Striker, black 137062
Striker Base 137062

Pressure Pump Bracket
Luer, male to female, white 137010
Luer, male cap, yellow 137025
Luer, male cap, green 137026
Luer, male cap, green 137026
Luer, male cap, blue 137028
Luer, male cap, red 137029
Barb, Reducer, 3/32 to 1/8 137099
Luer, female, 3/32" barb, bulkhead 137102
Coding Ring green 137114
Coding Ring black 137115
Coding Ring yellow 137116
Coding Ring blue 137117
Coding Ring red 137118

Probe X Mover
Coupling 1/8" 137008

Syringe Pump
Luer, female to 1/4-28 unf-poly 137013
Plug, 1/4-28 UNF W 1/4" Hex 137014

Wash Cup
Plug, 1/4-28 UNF W 1/4" Hex 137014

Washer
Luer, rotating lock ring, red 137011
Luer, rotating lock ring, blue 13701
Luer, male to female, white 137010
Luer, male cap, nylon, blue 137028
Luer, male cap, nylon, red 137029
Luer, male, 3/32”, barb, nylon 137121
Luer, male, 1/8” barb, nylon, blue 137128

Wash Head
Luer, female, 10-32, red 137124
Luer, female, 10-32, blue 137126

Waste Trough
Elbow, male, 3/8"OD, 1/4" NPT 137138
Elbow, 1/8-27 NPT threaded 7/16 Hex 137145

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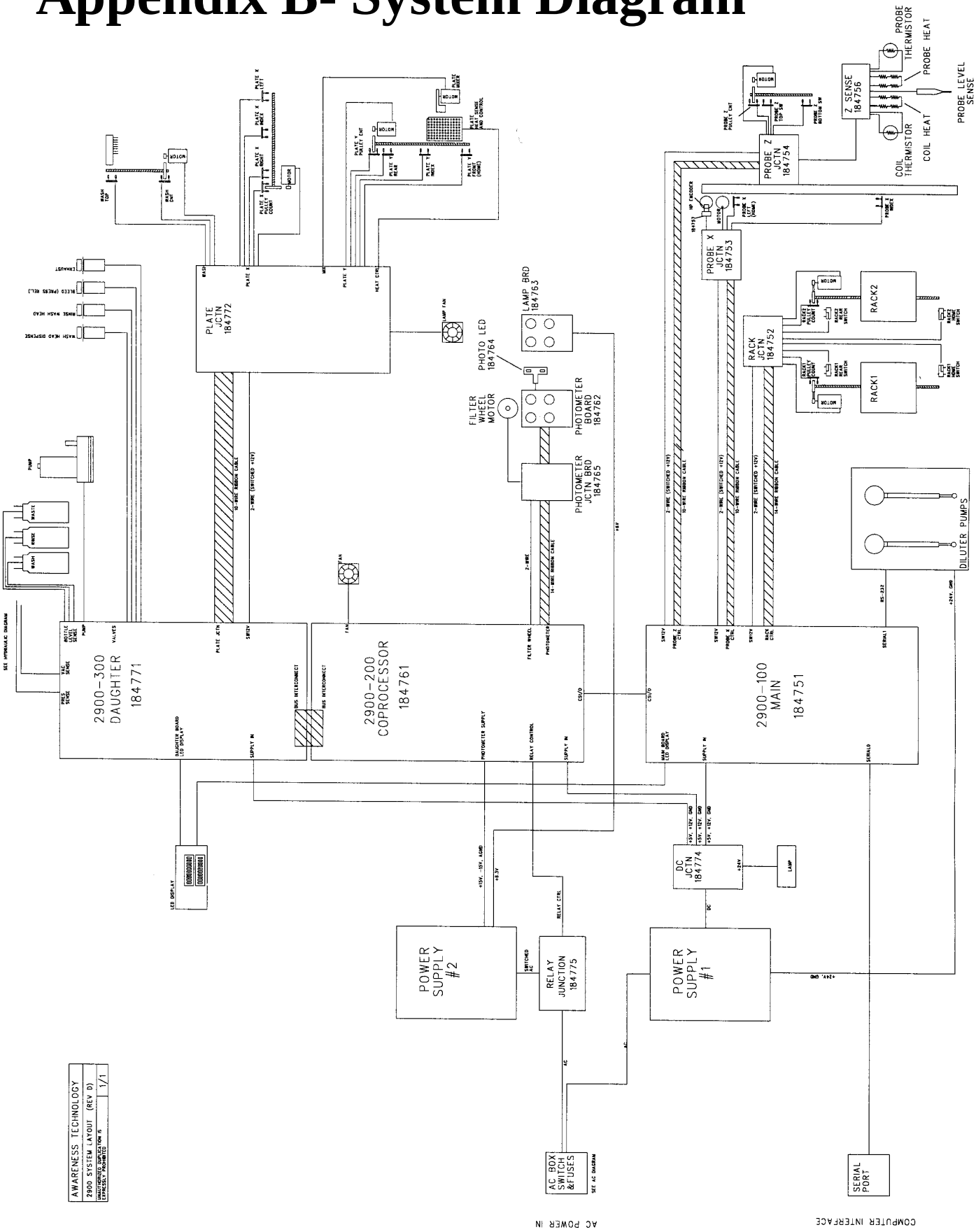
Appendix B- System Diagram



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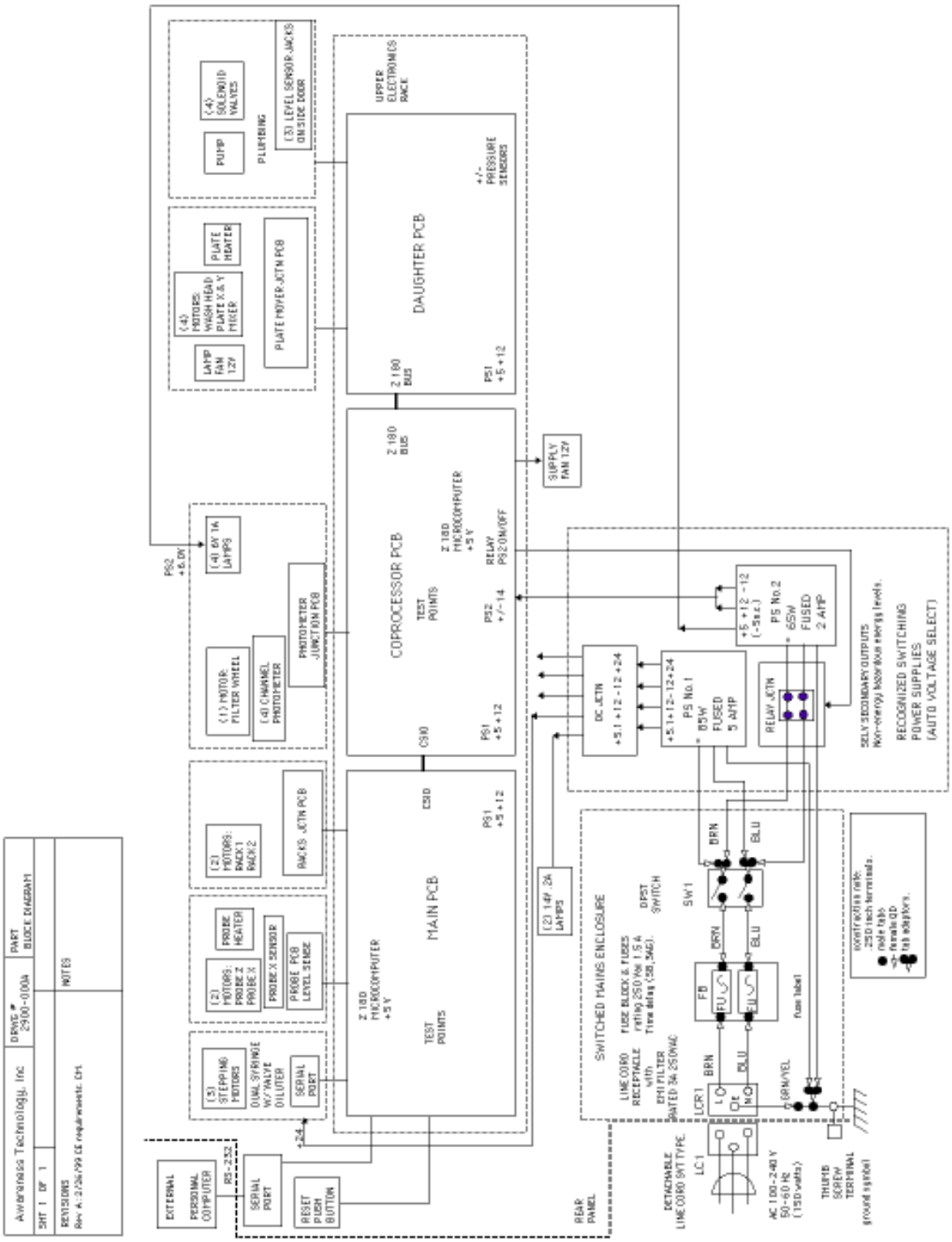
Appendix C- Block Diagram



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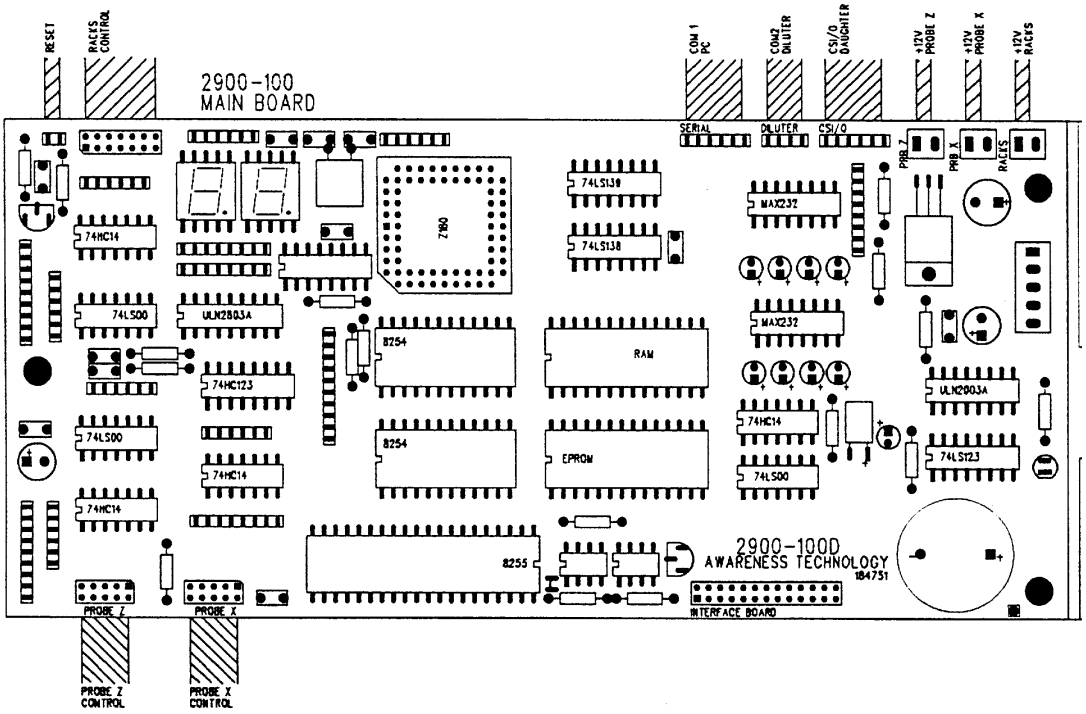
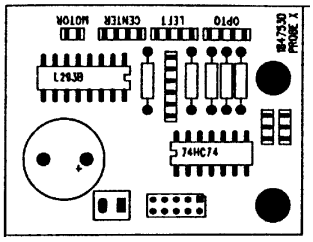
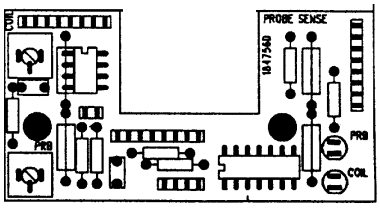
Appendix D- PCB Layouts



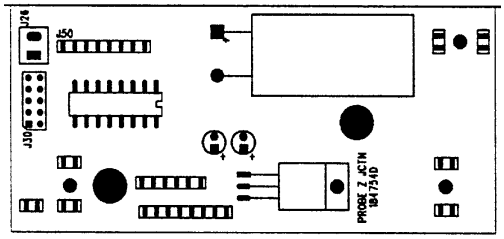
Main PCB (995310)



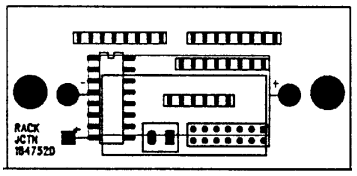
PCB Probe X Junction (995312)



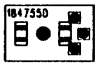
PCB Probe Sensor/ Heater Control (995315)



PCB Probe Z Mover (995313)



PCB Rack Junction (995311)



PCB Opto

PCB Encoder Reader

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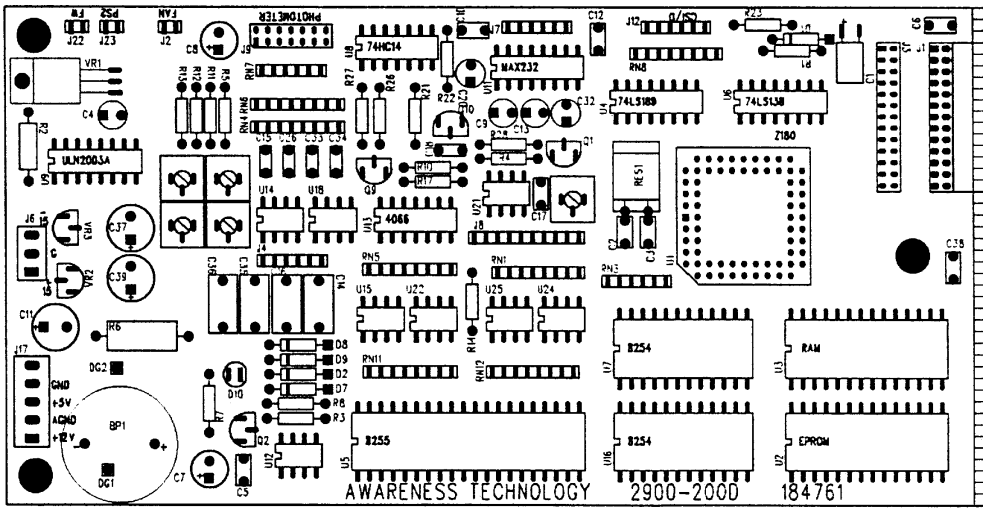
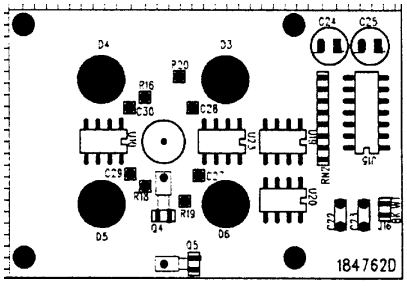
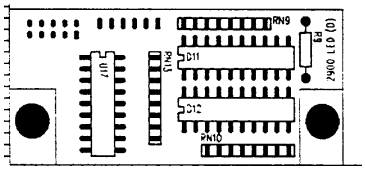


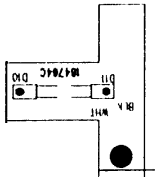
Coprocessor PCB (995320)



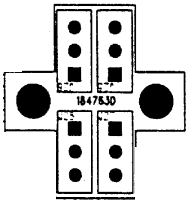
PCB Photometer (995321)



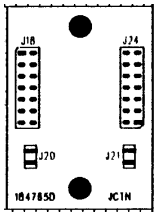
PCB LED (995336)



PCB Photometer LED (995323)



PCB Lamp (995322)



PCB Photometer Junction (995324)

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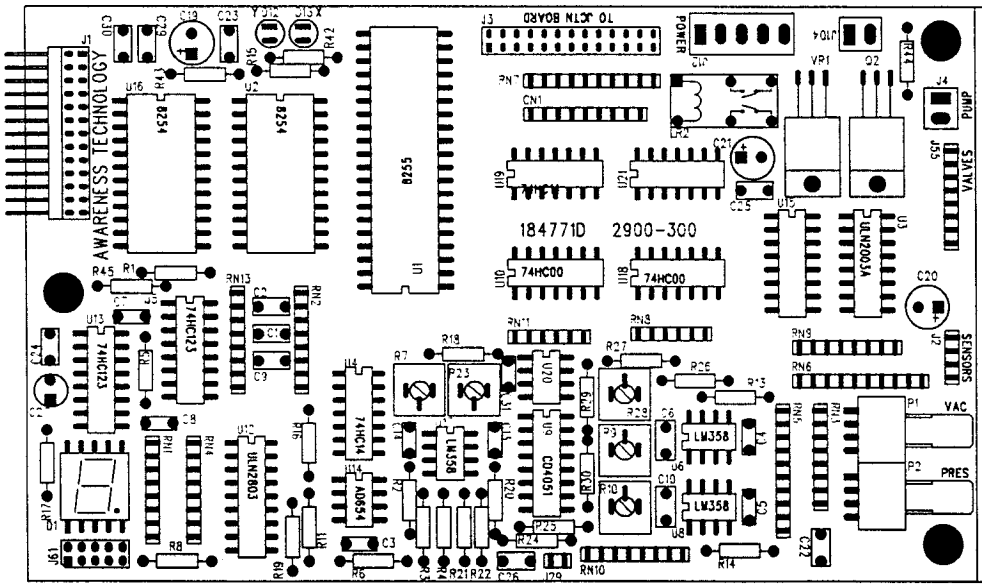
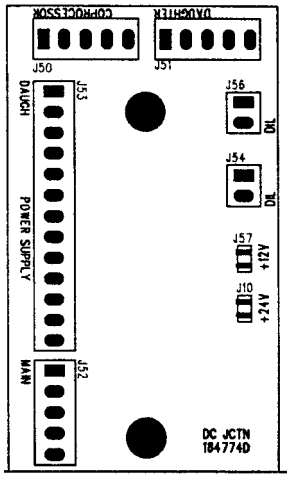


Daughter PCB (995330)



DC Junction (995333)

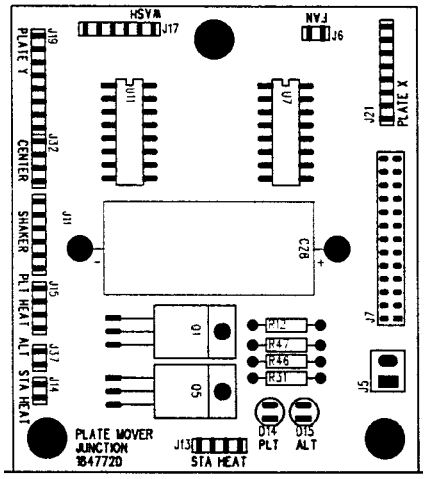
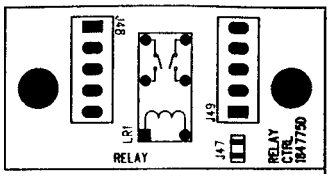


Plate Mover Junction (995331)



Relay Junction Board (995334)

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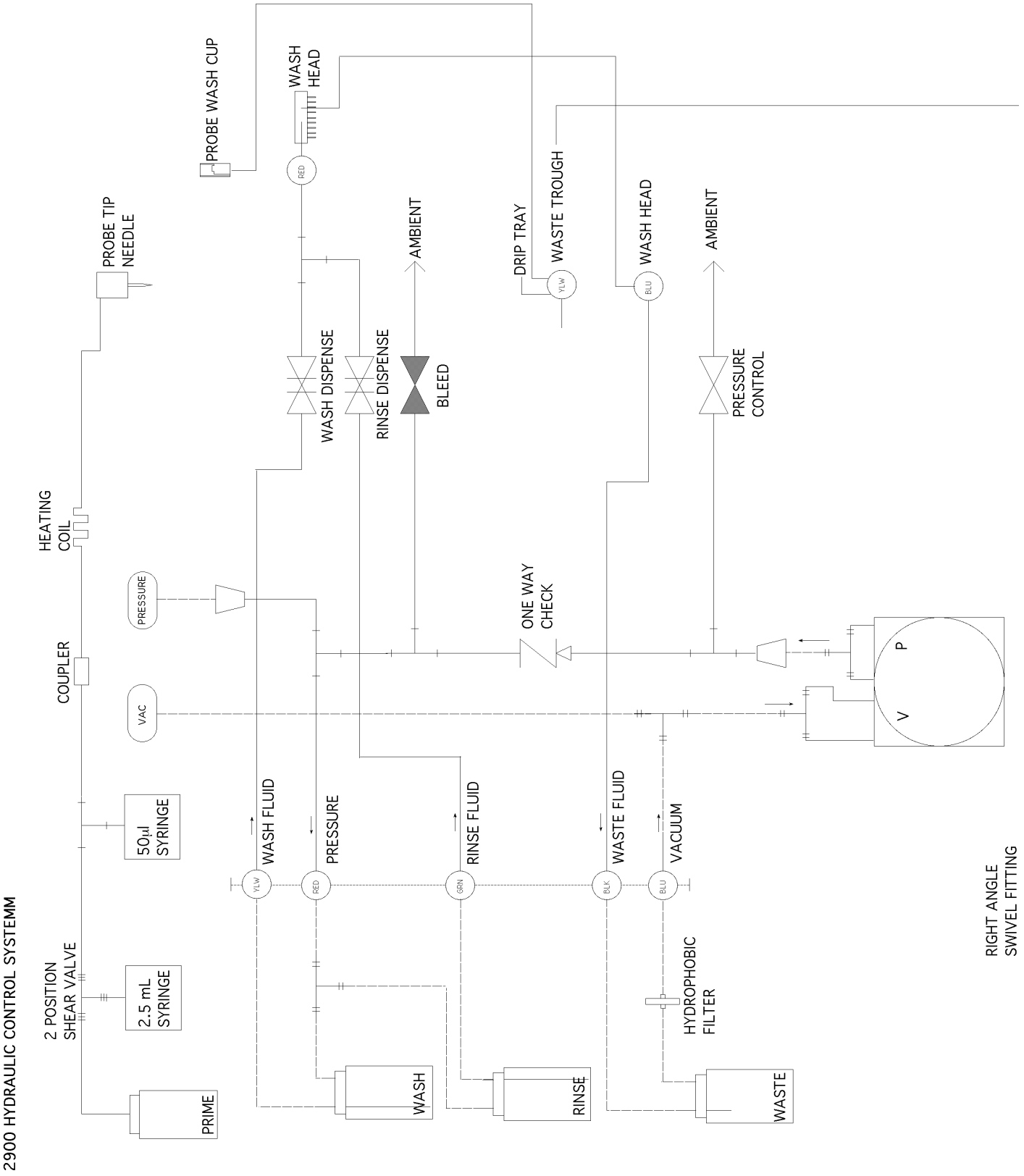
Appendix E- Internal Plumbing



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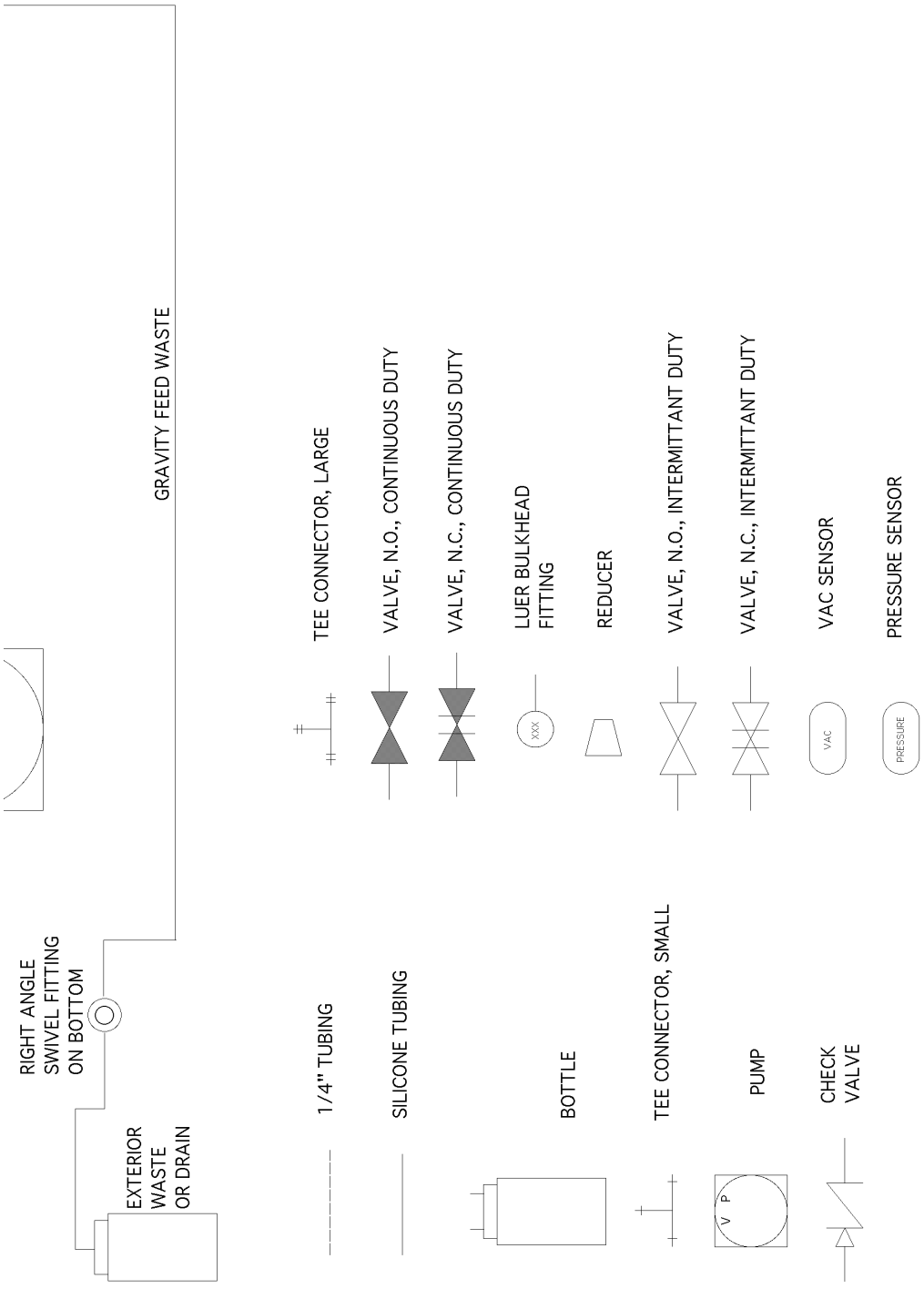

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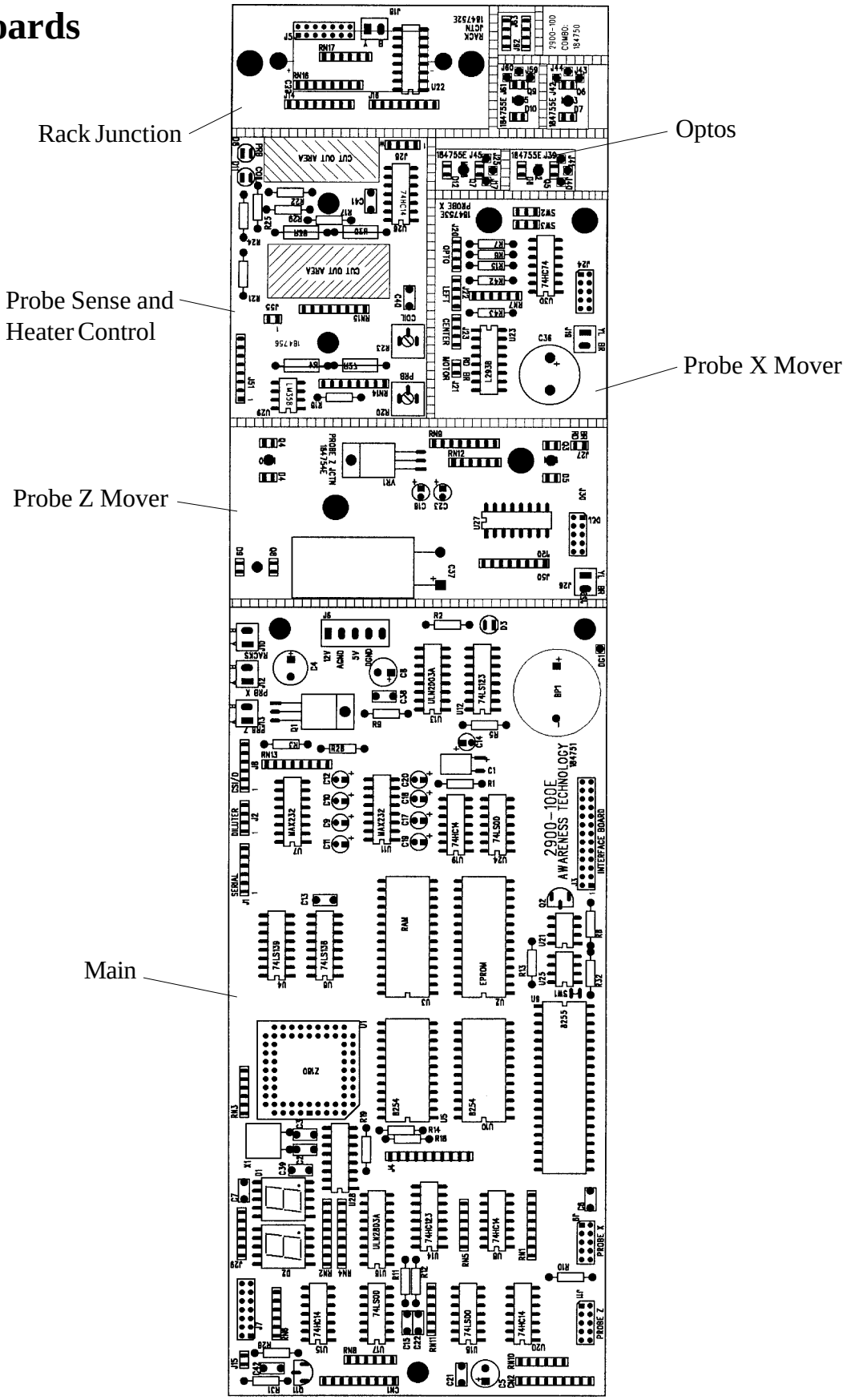
Appendix F- Schematics

Rev. E Boards



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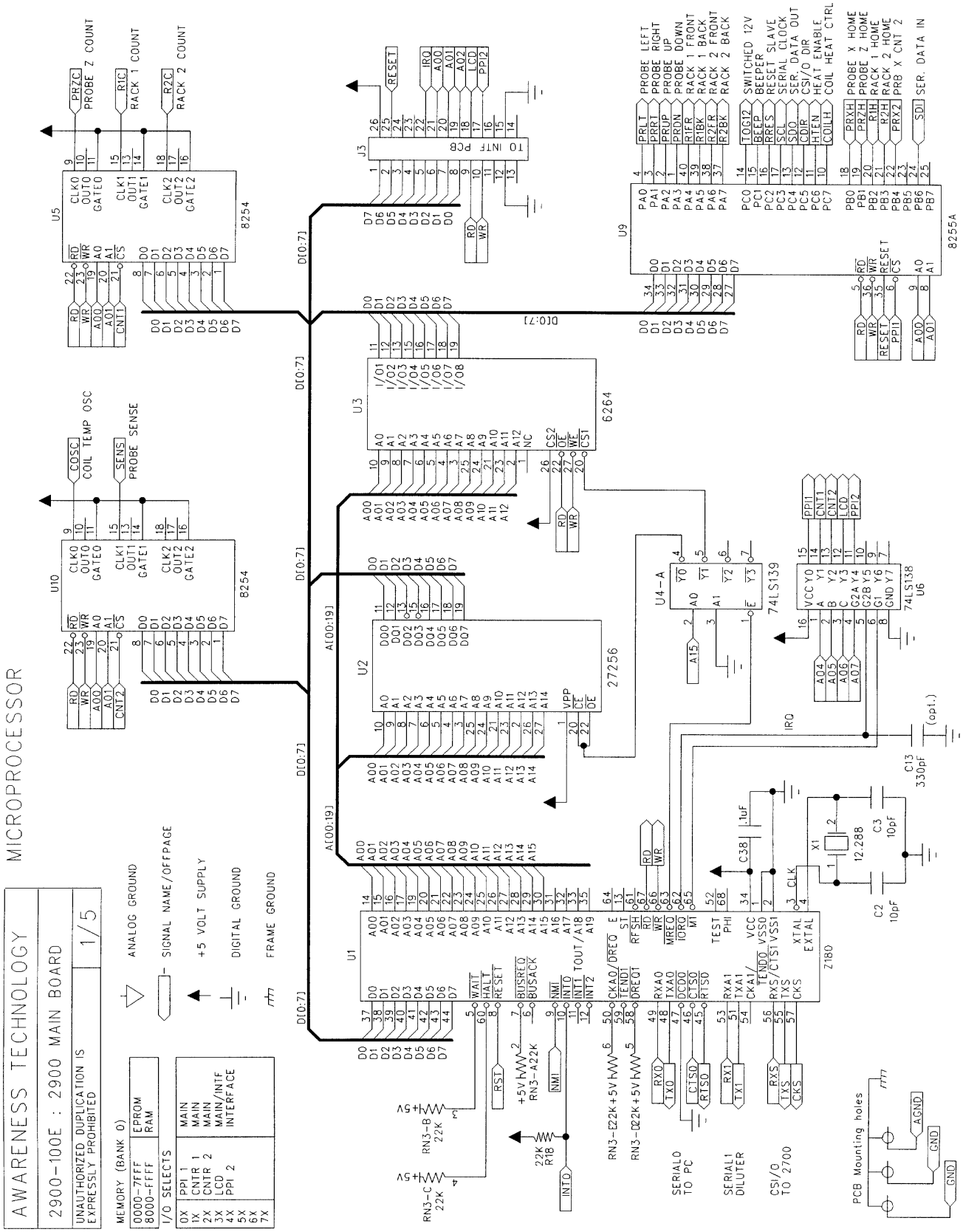
Main PCB (1 of 5)



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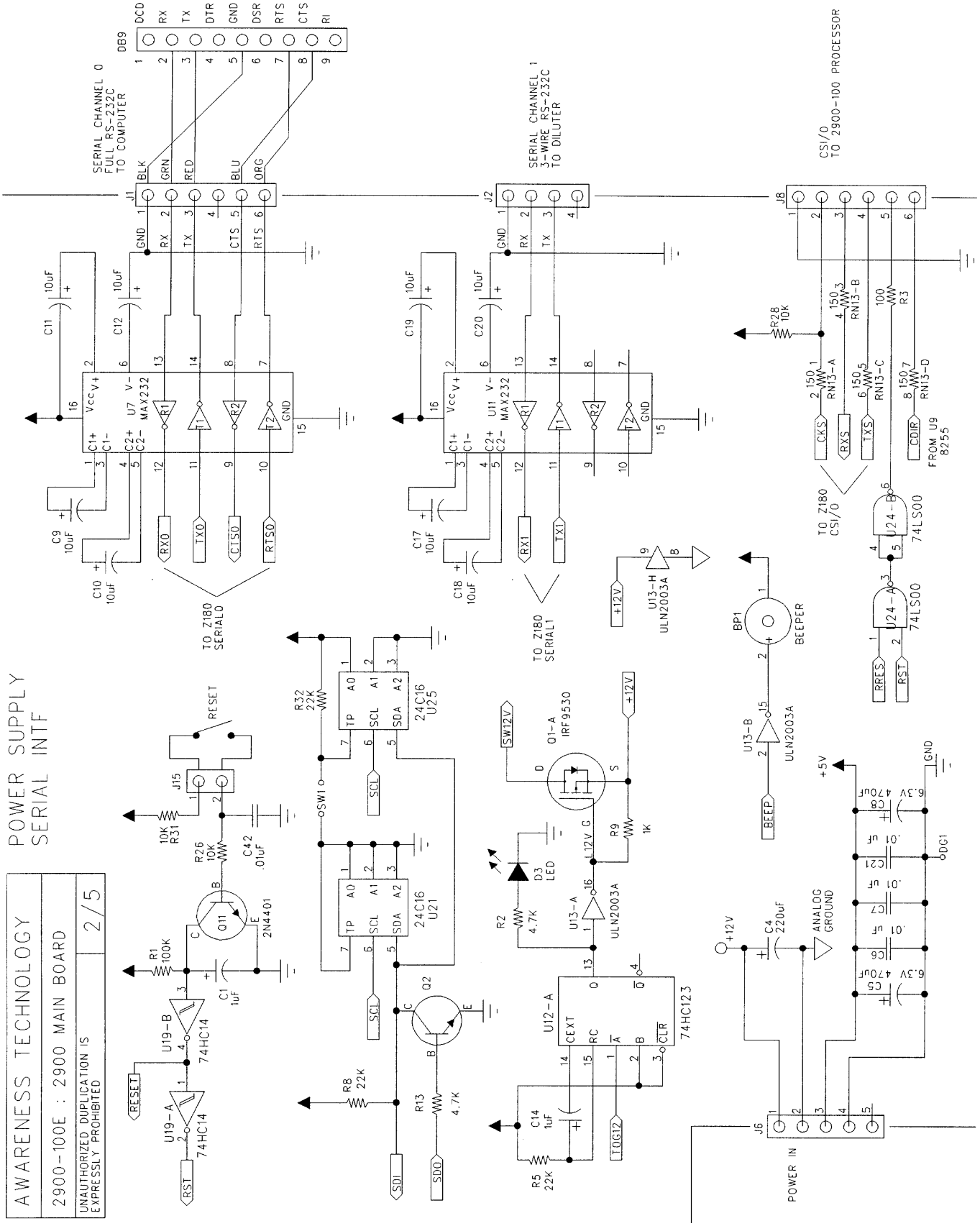
Main PCB (2 of 5)



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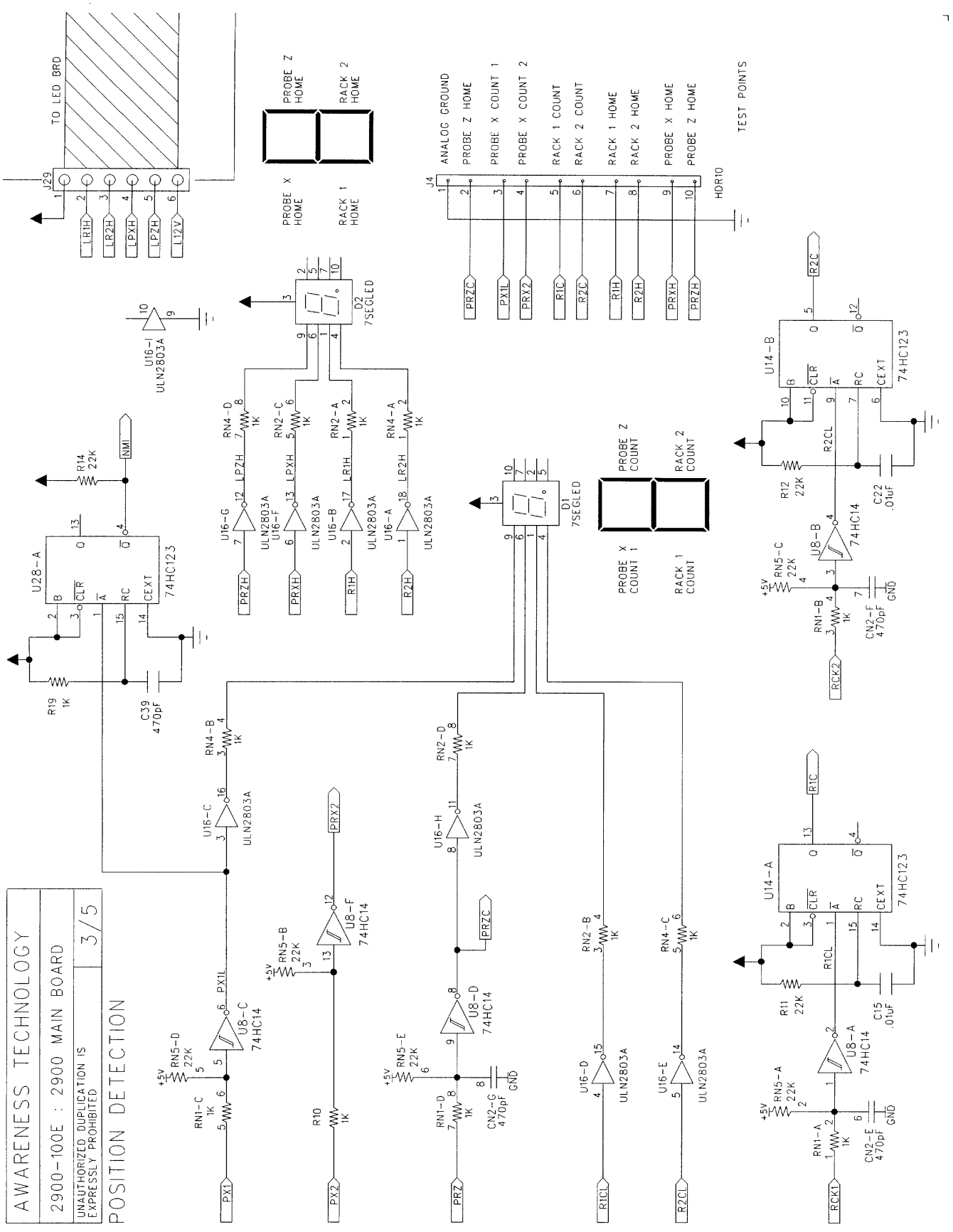
Main PCB (3 of 5)



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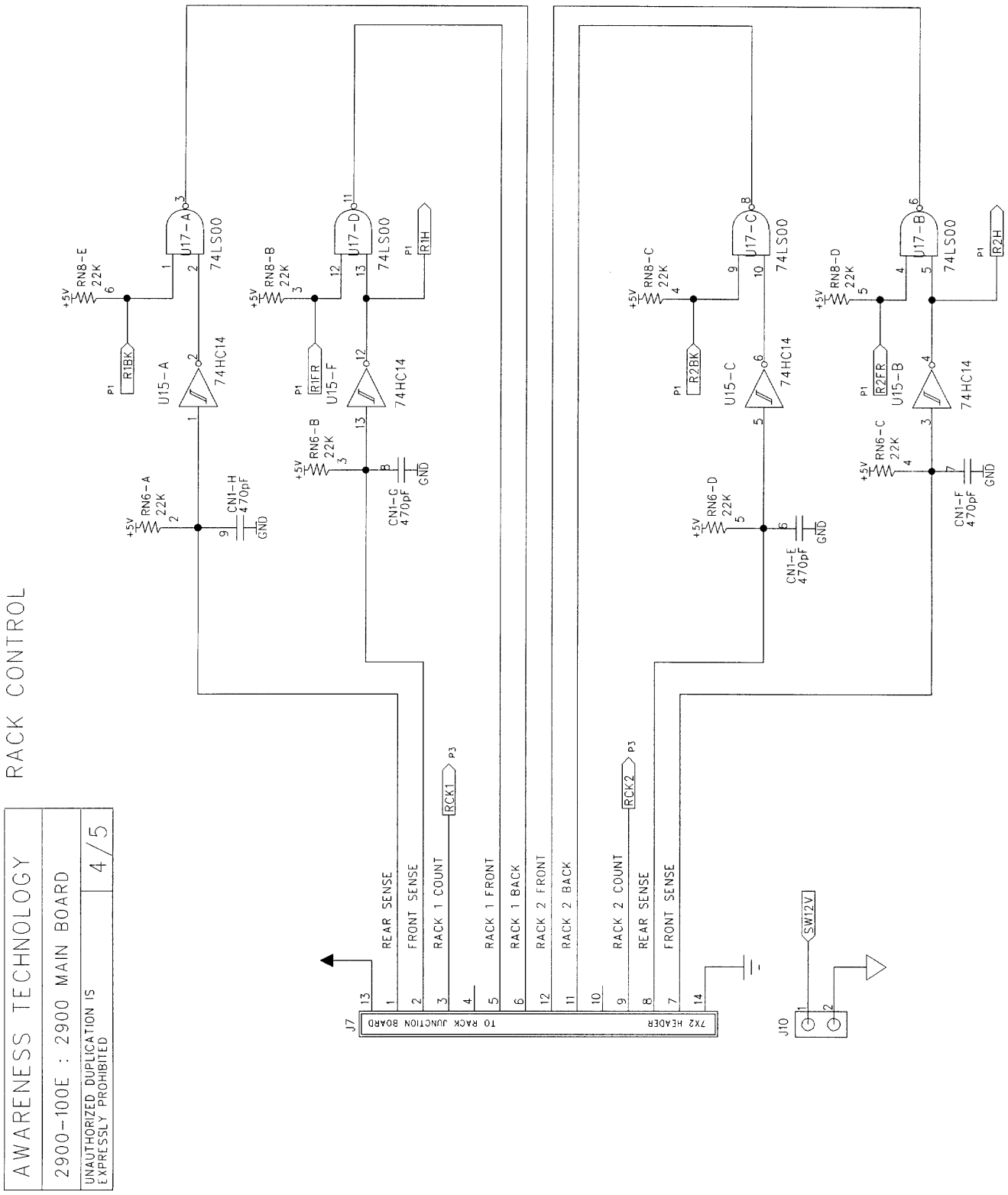
Main PCB (4 of 5)



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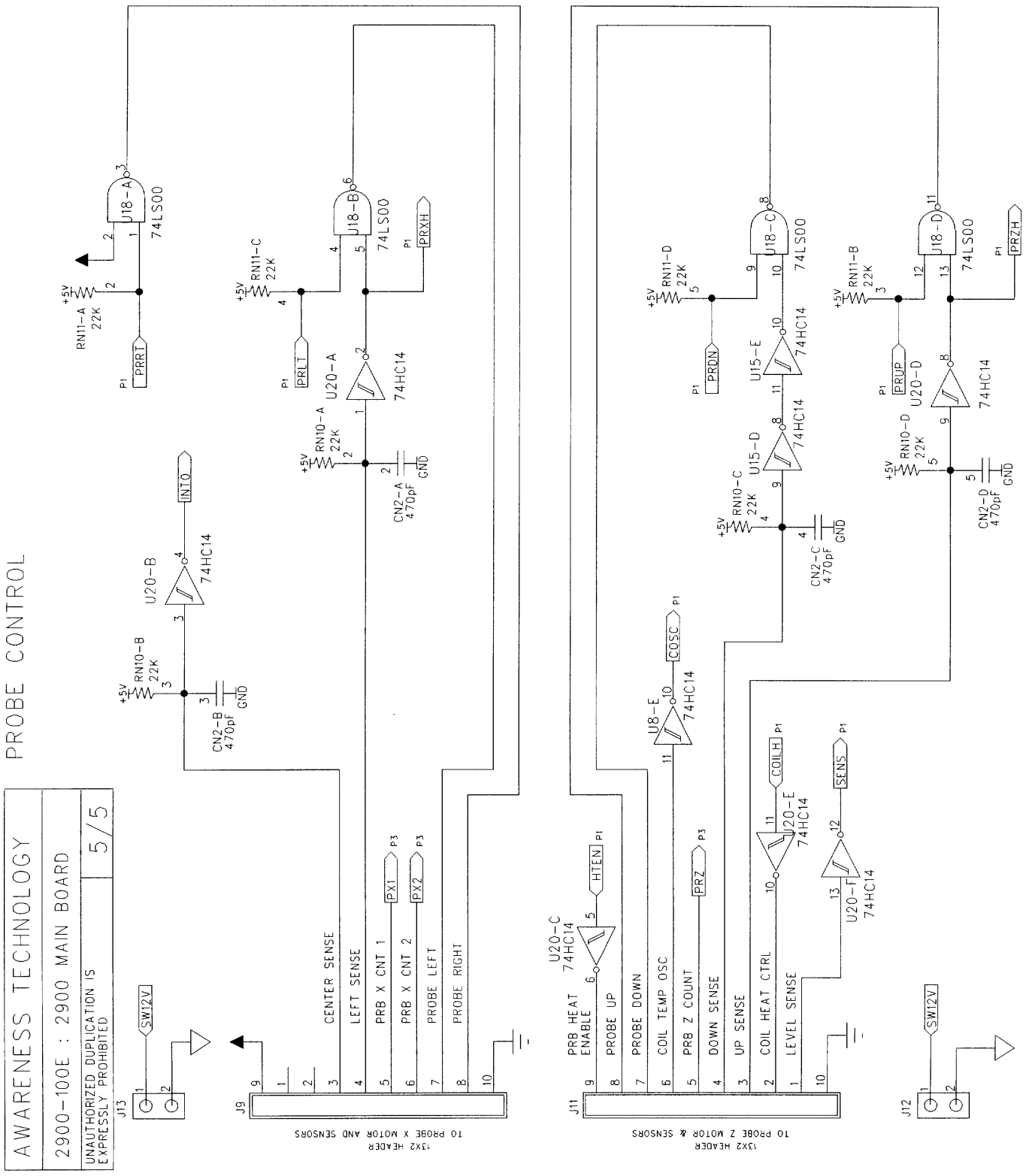
Main PCB (5 of 5)



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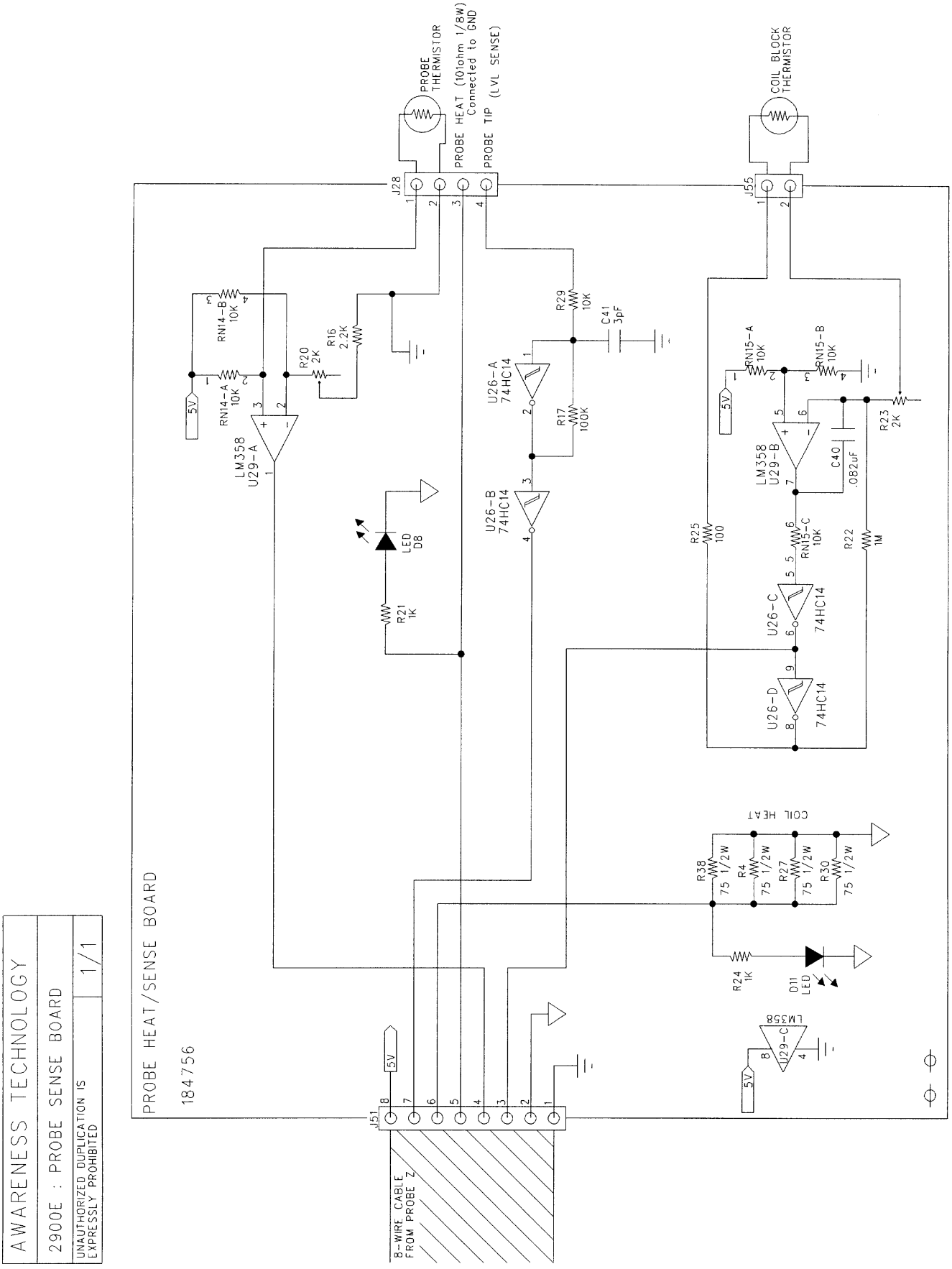
Probe Sensor and Heater Control PCB



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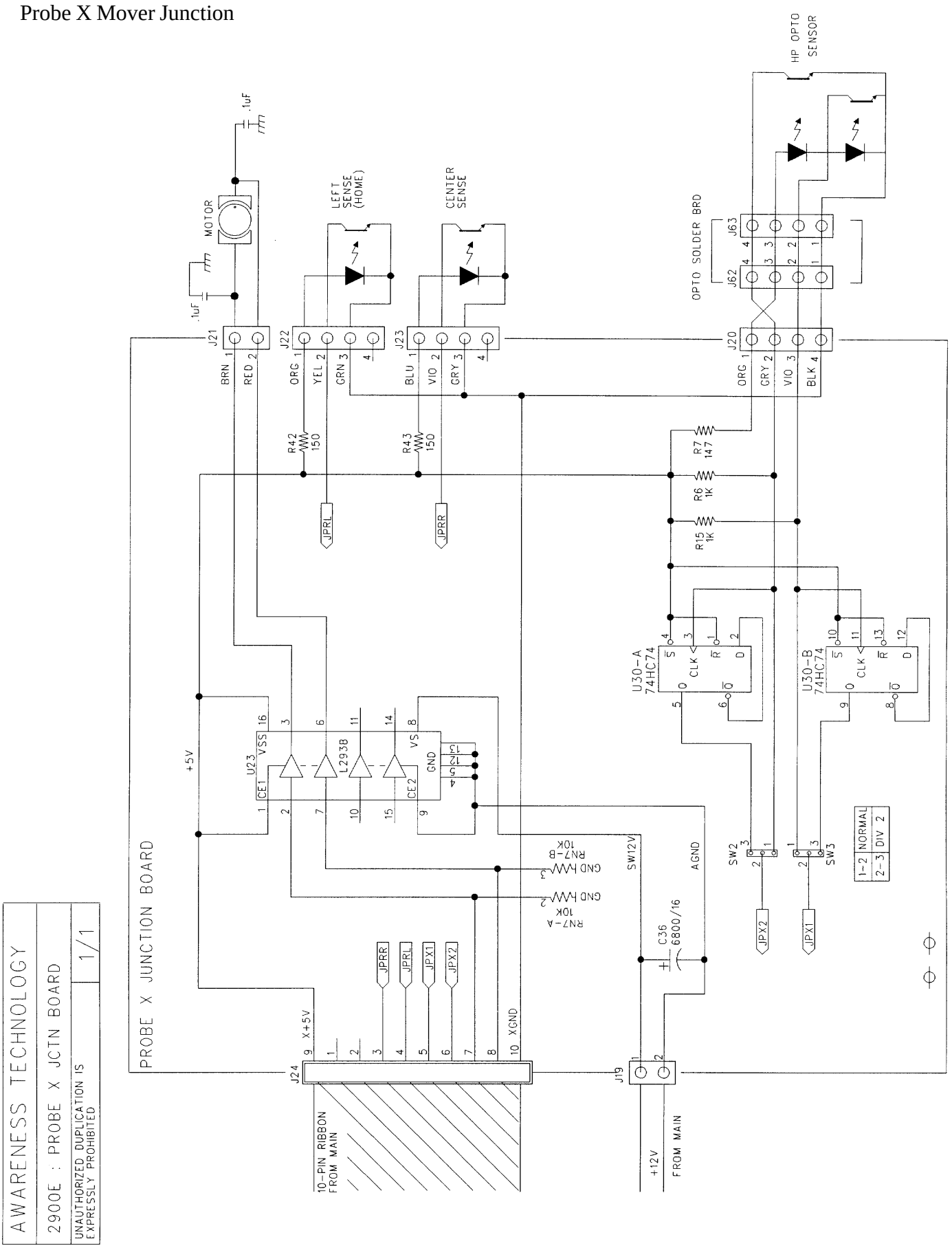
Probe X Mover Junction



AWARENESS TECHNOLOGY	
2900E : PROBE X JCTN BOARD	1/1
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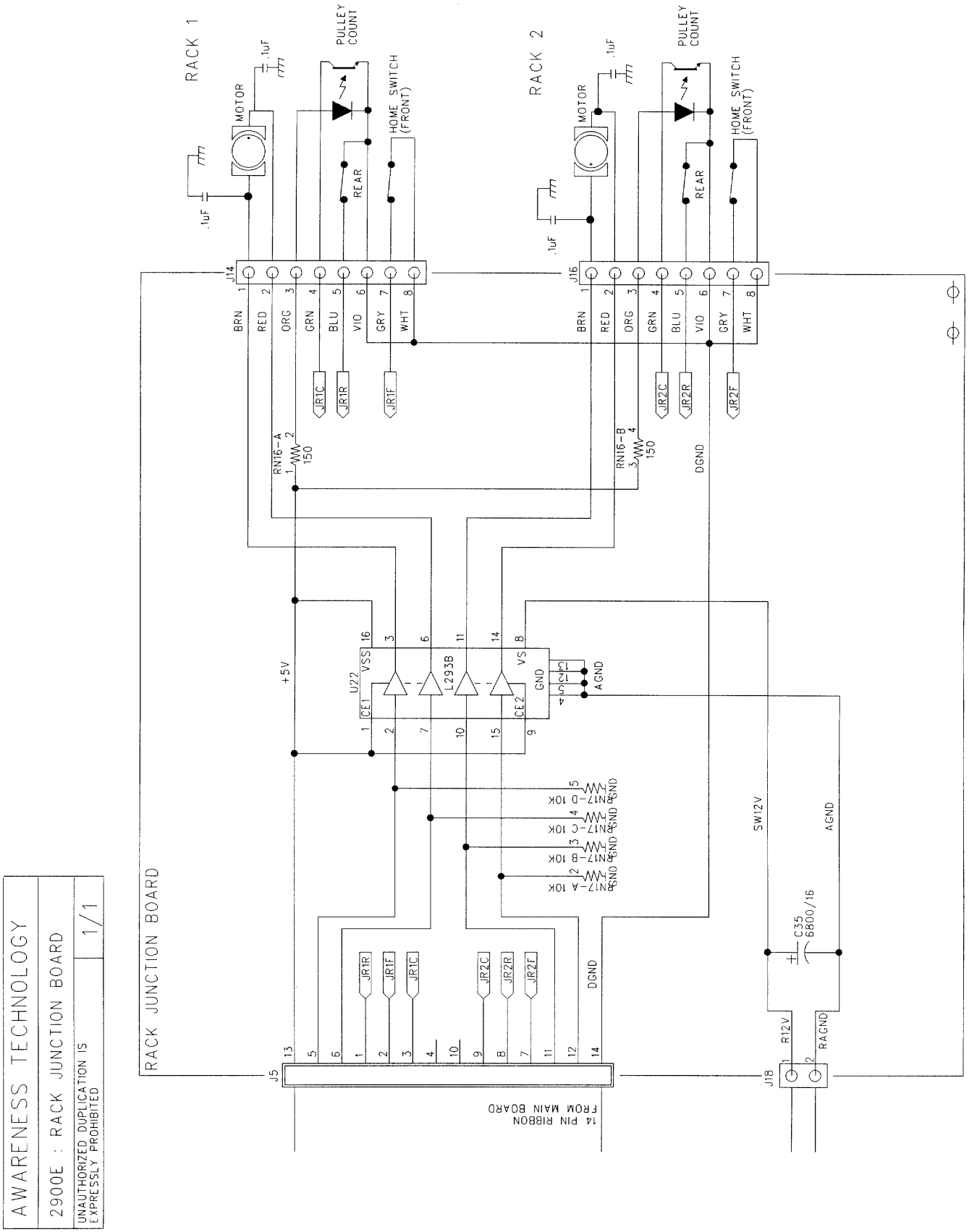
Rack Junction



AWARENESS TECHNOLOGY
2900E : RACK JUNCTION BOARD 1/1
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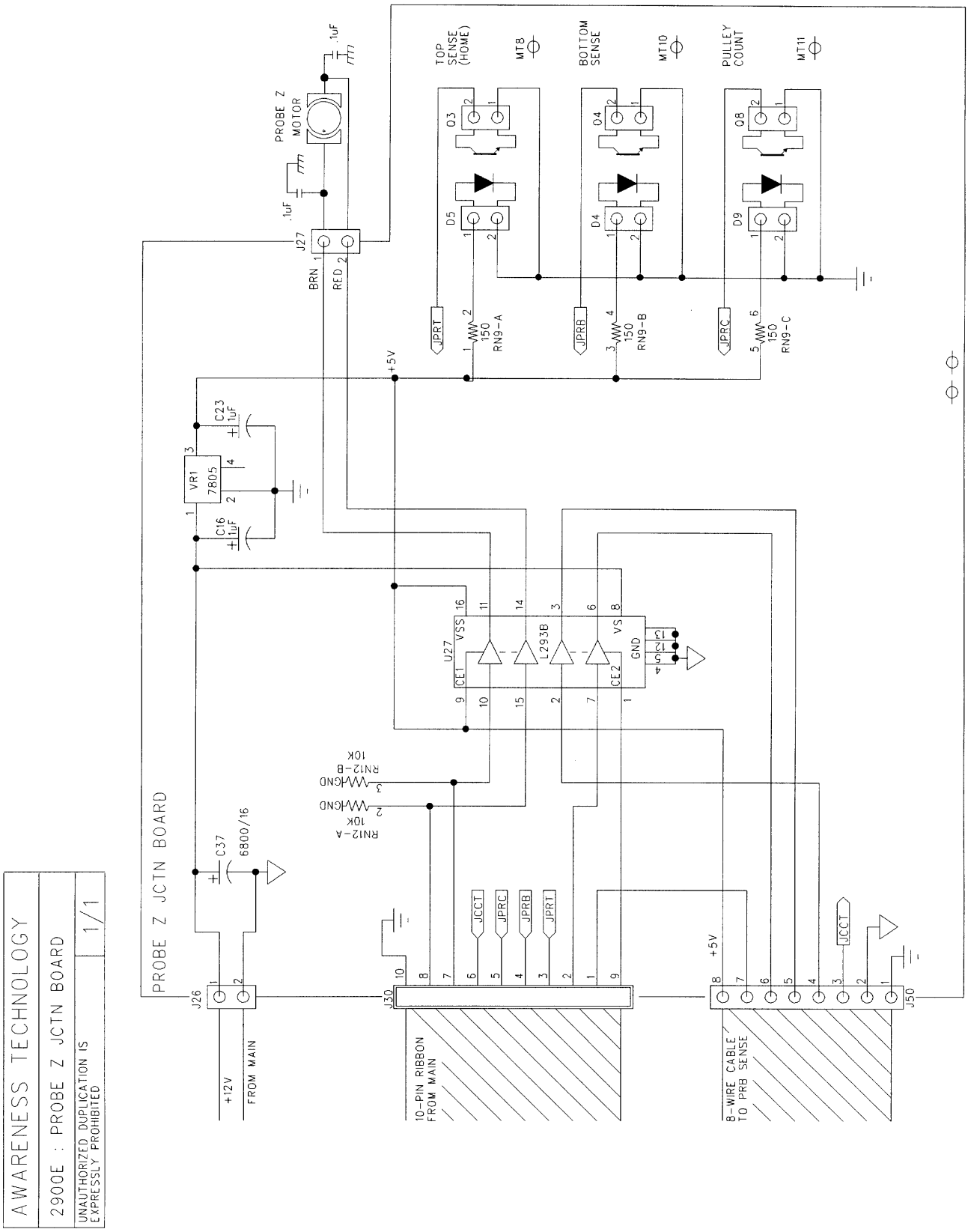
Probe Z Junction



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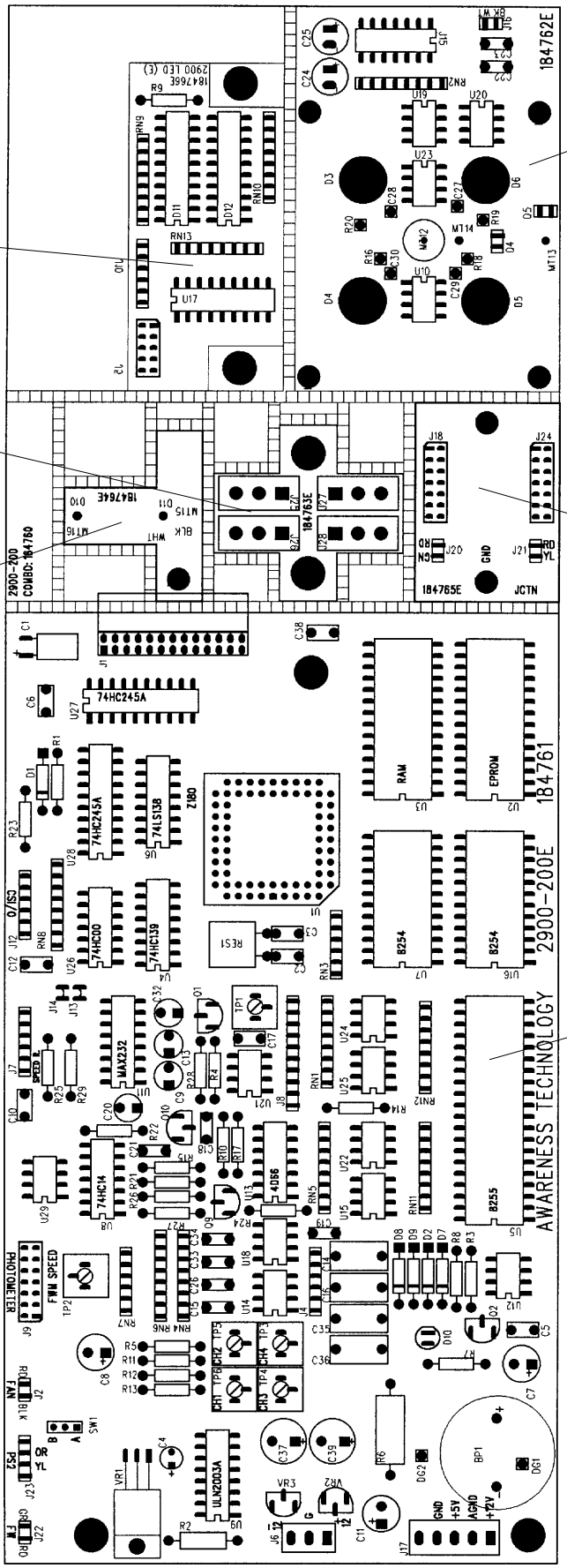
Rev. E



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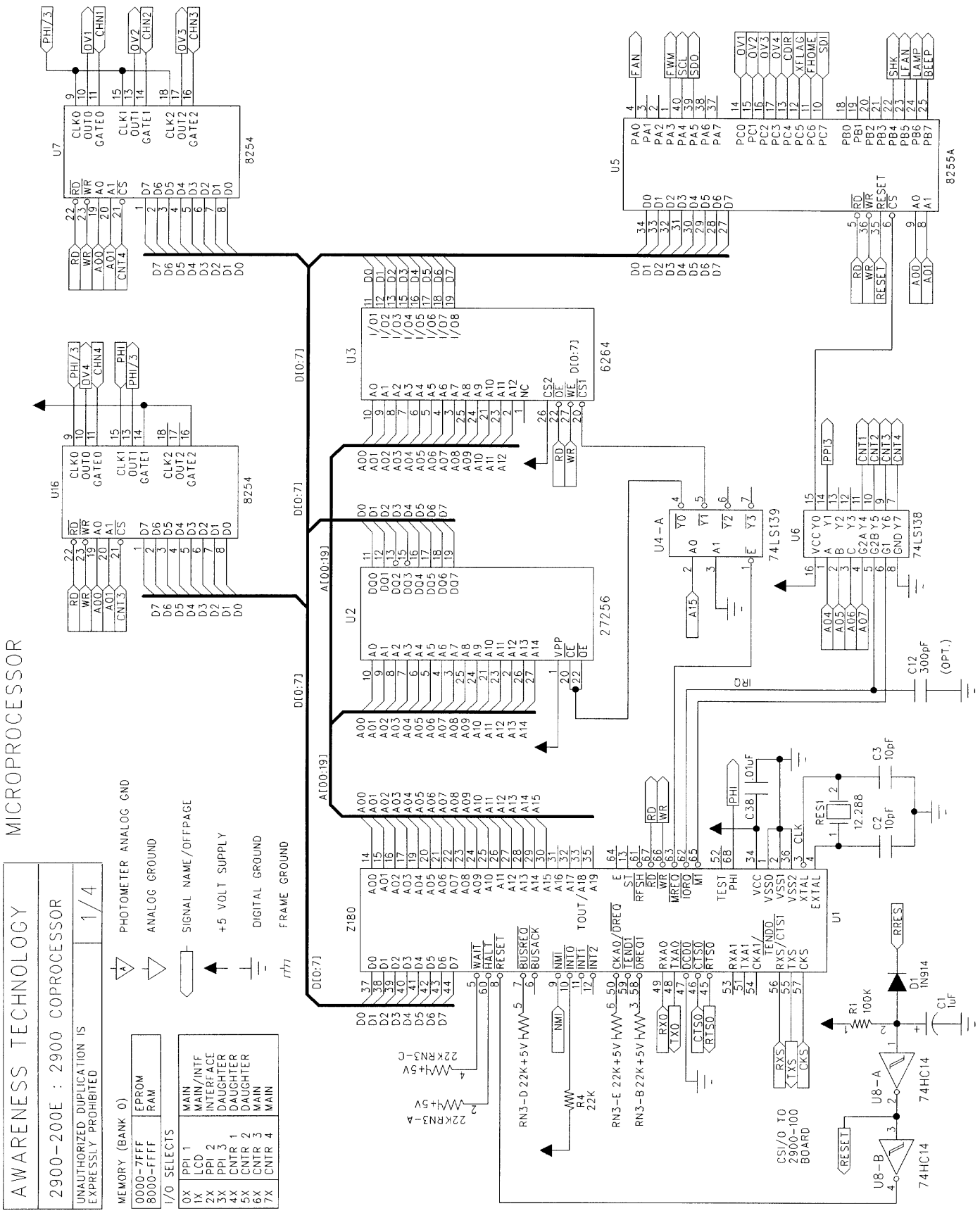
Coprocessor PCB (1 of 4)



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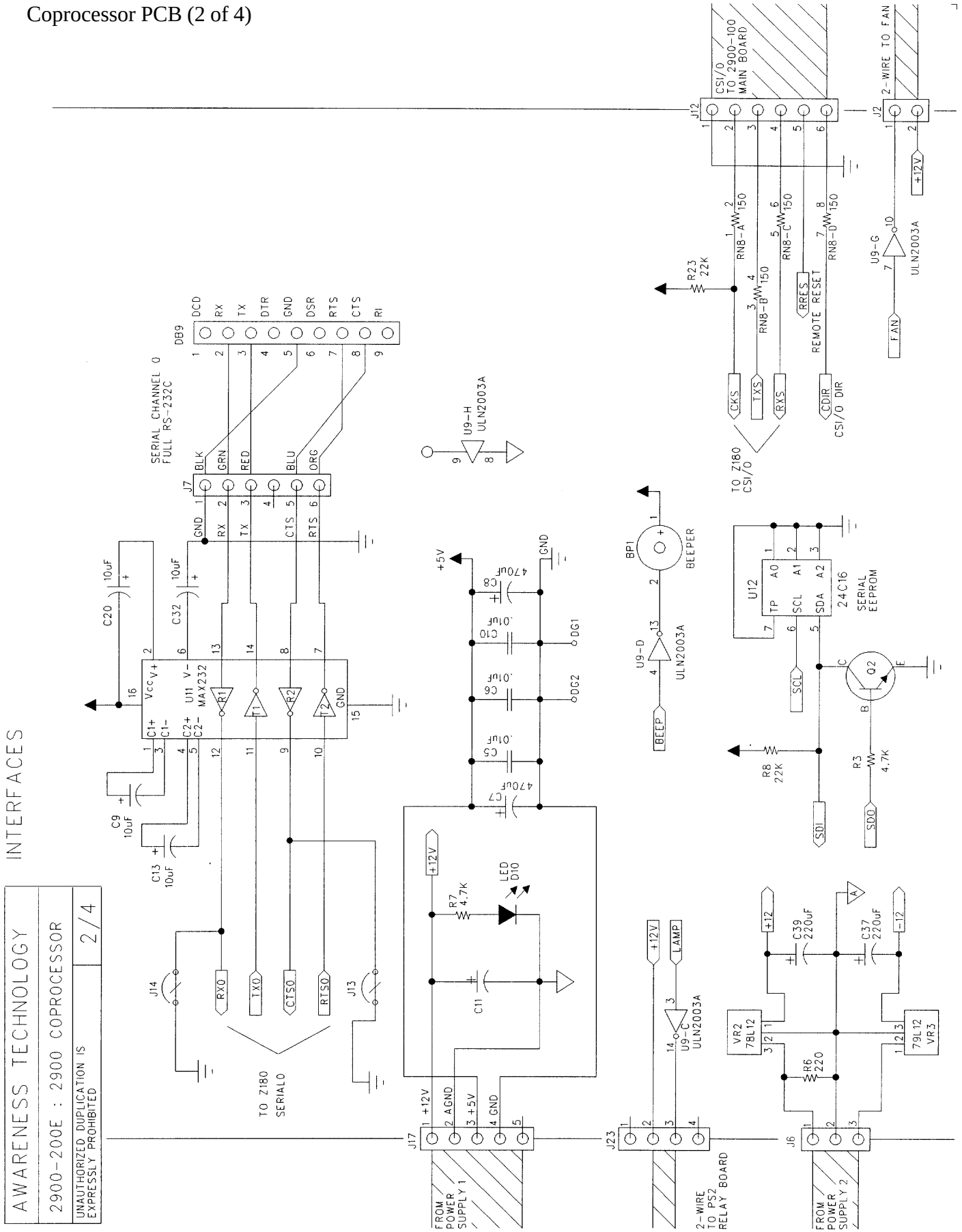
Coprocessor PCB (2 of 4)



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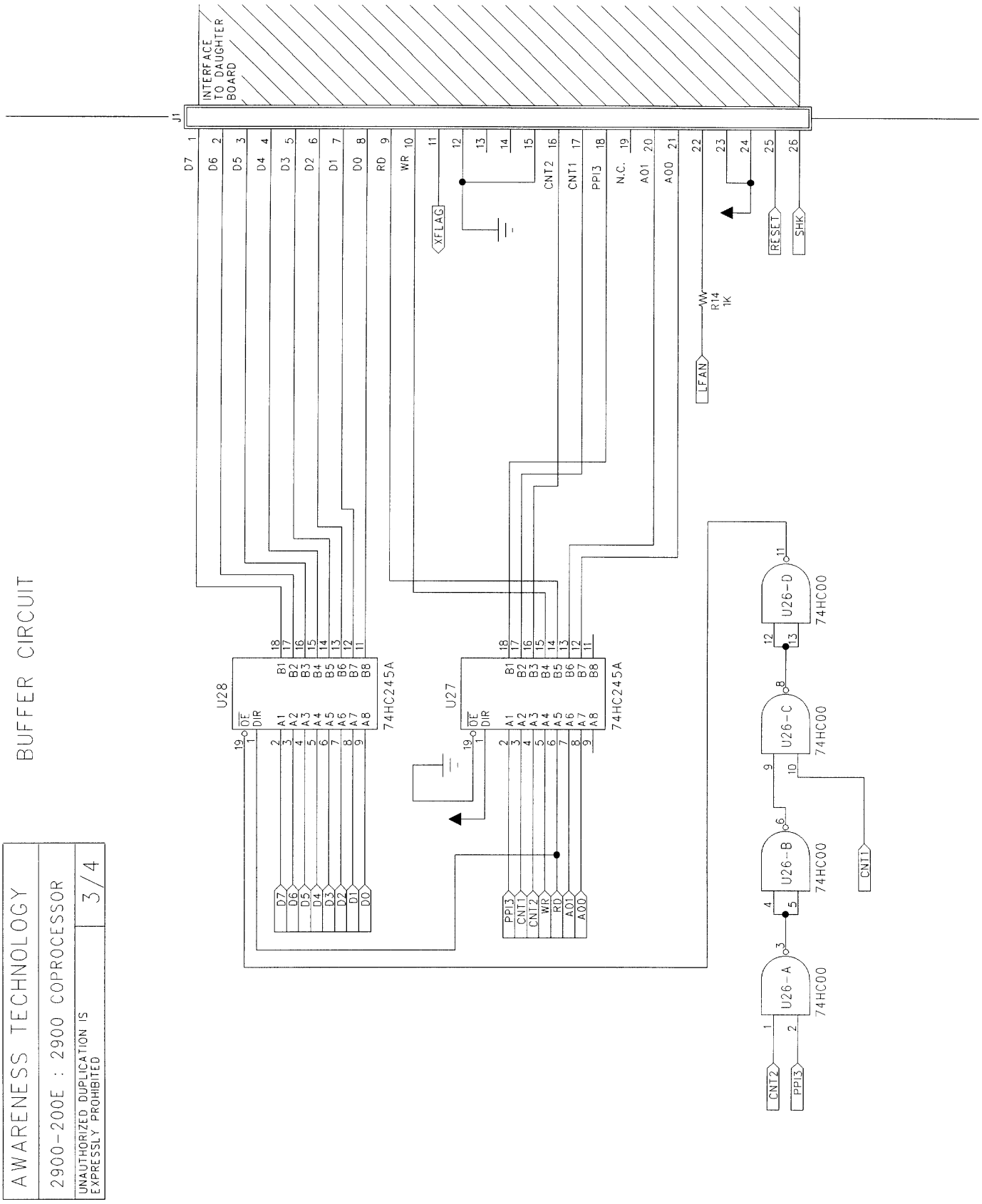
Coprocessor PCB (3 of 4)



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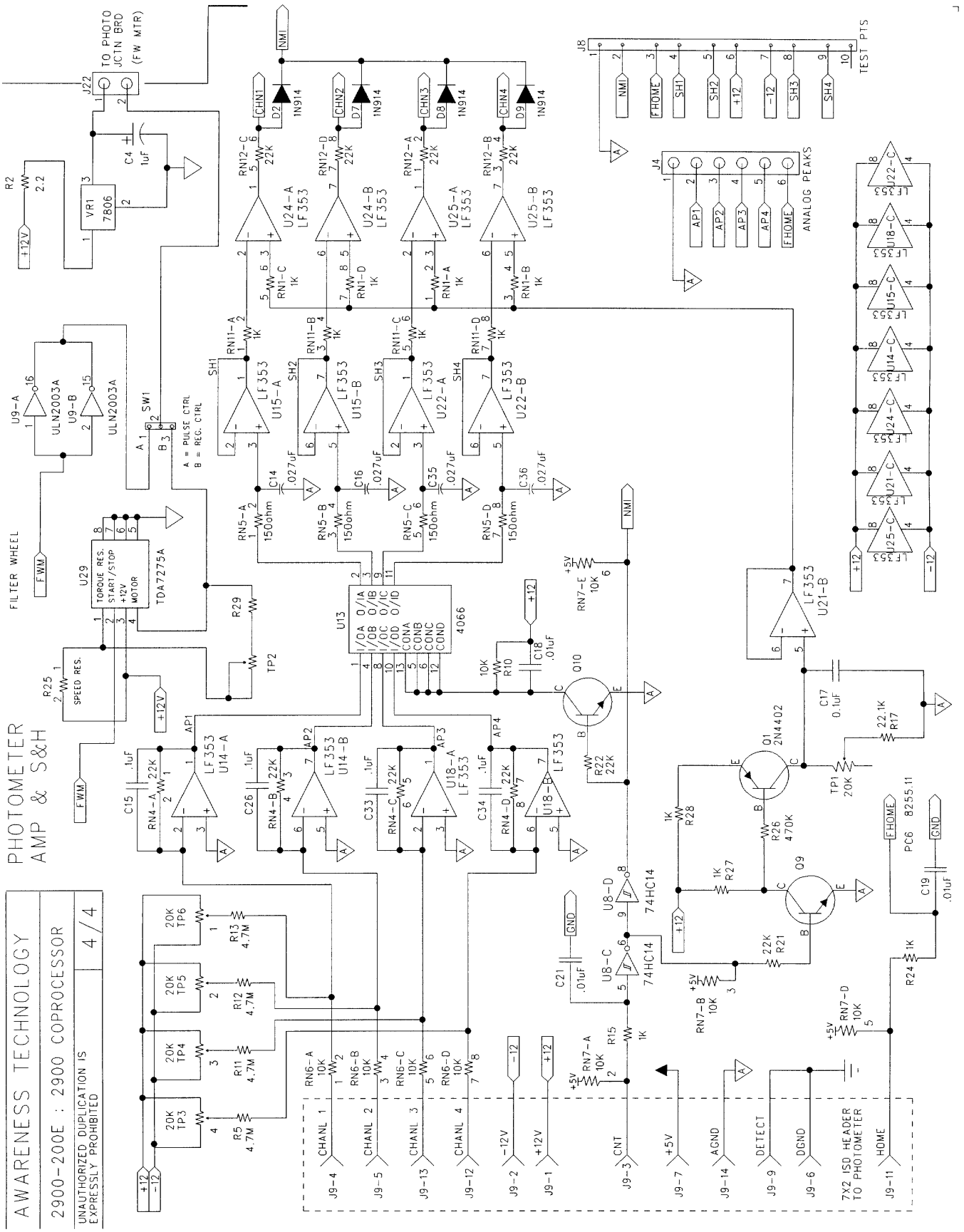
Coprocessor PCB (4 of 4)



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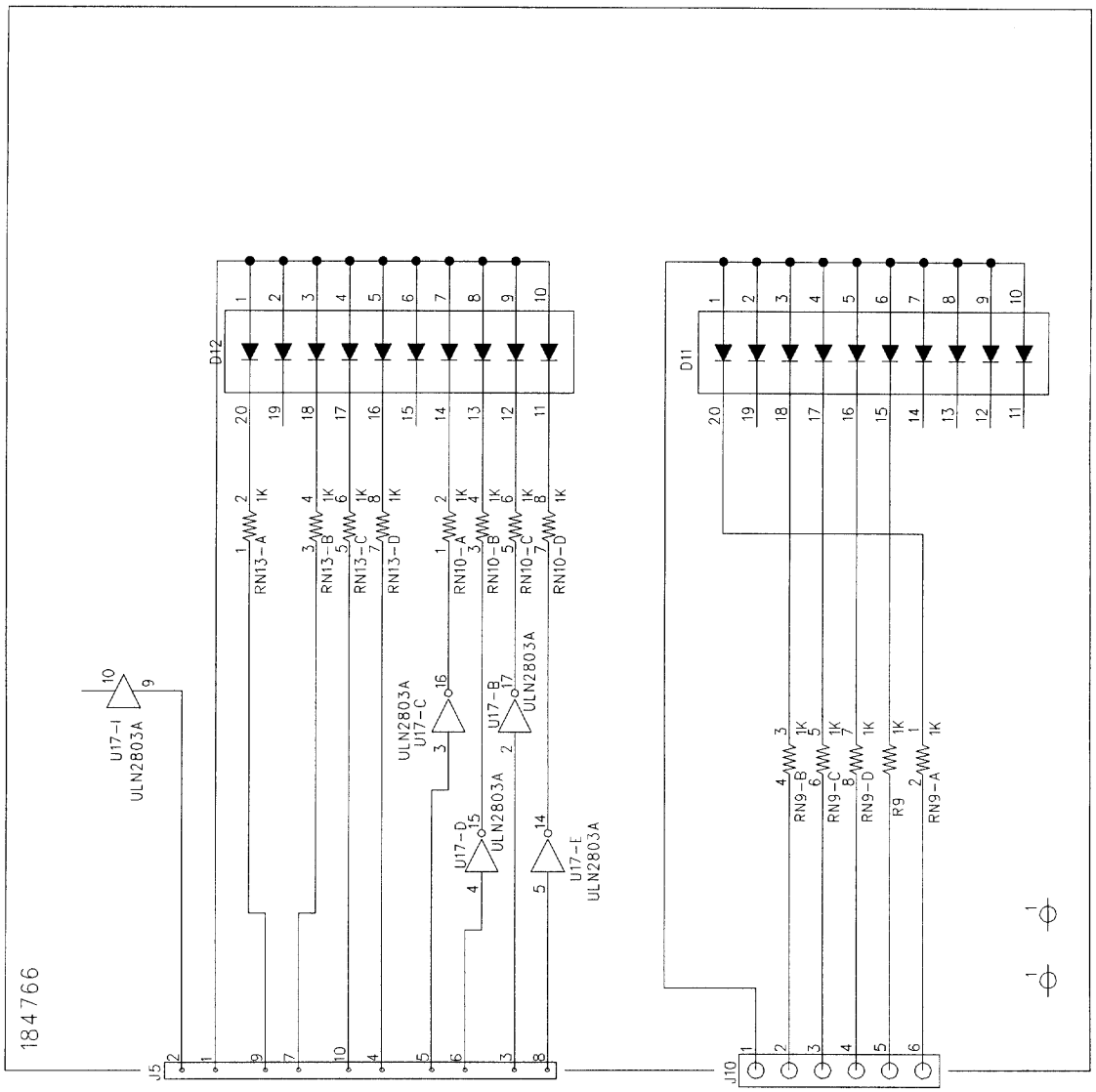
LED Display PCB



AWARENESS TECHNOLOGY

2900E: LED DISPLAY BOARD 1/1

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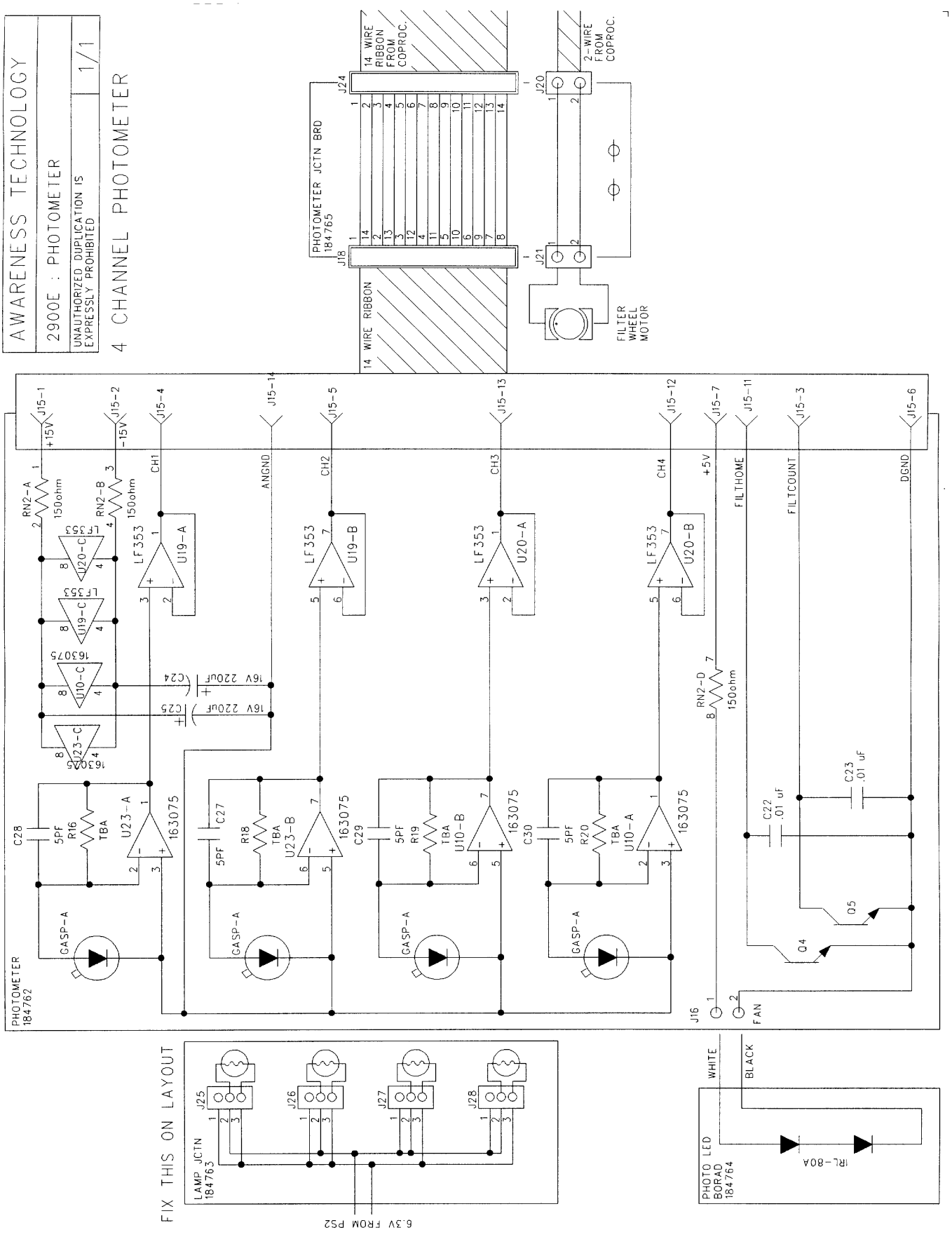
Photometer PCB



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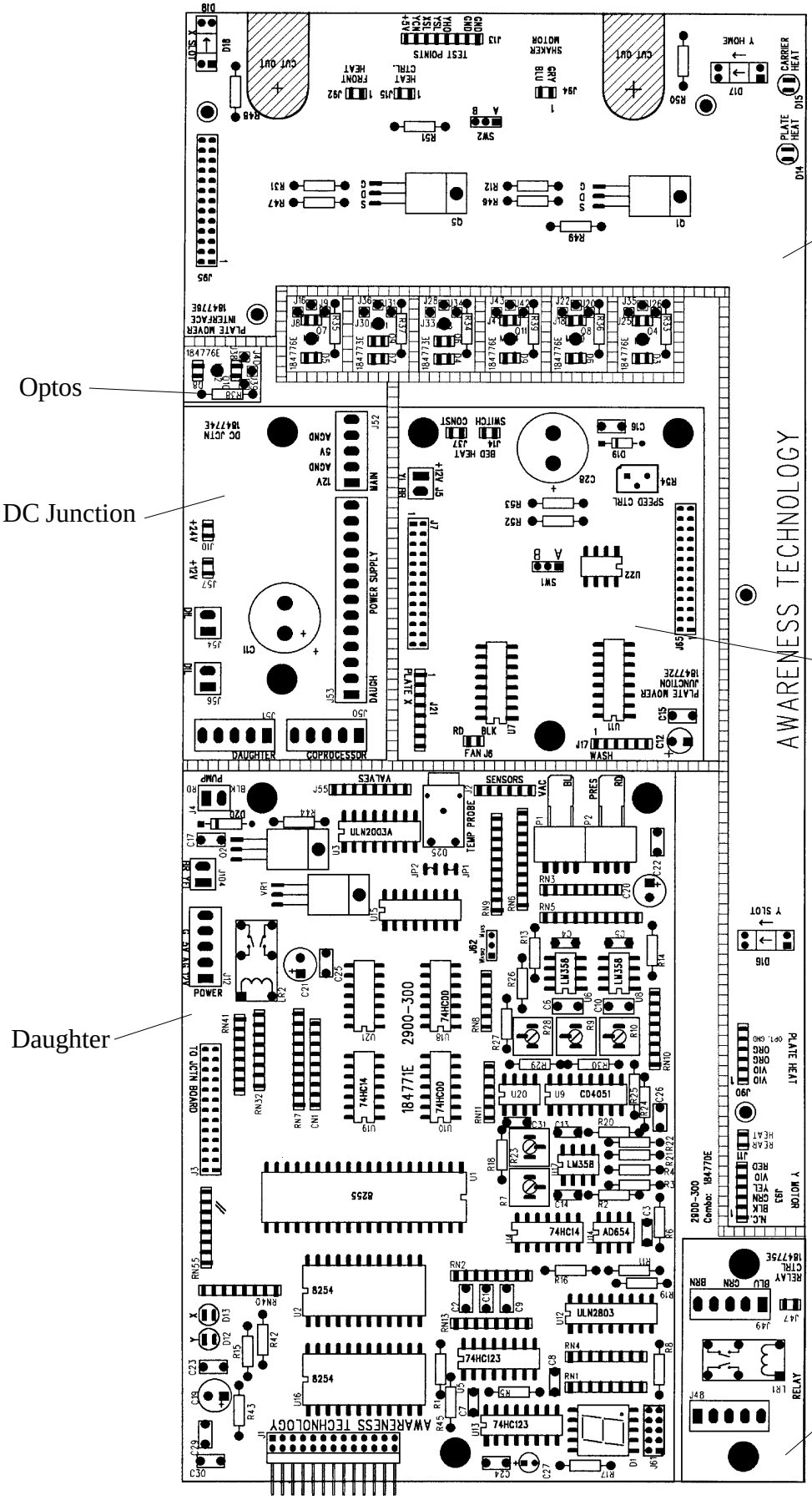
Rev. E



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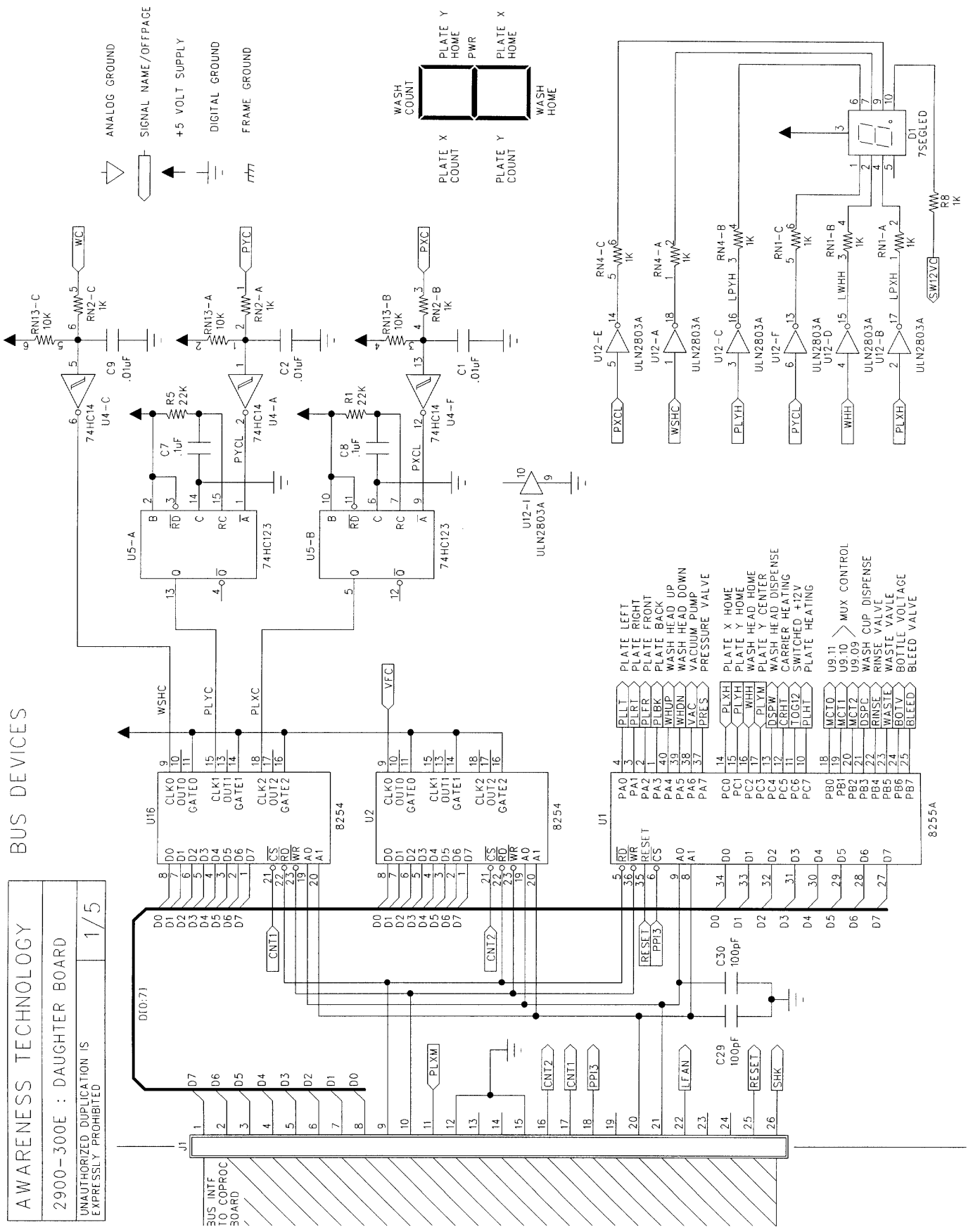
Daughter PCB (1 of 5)



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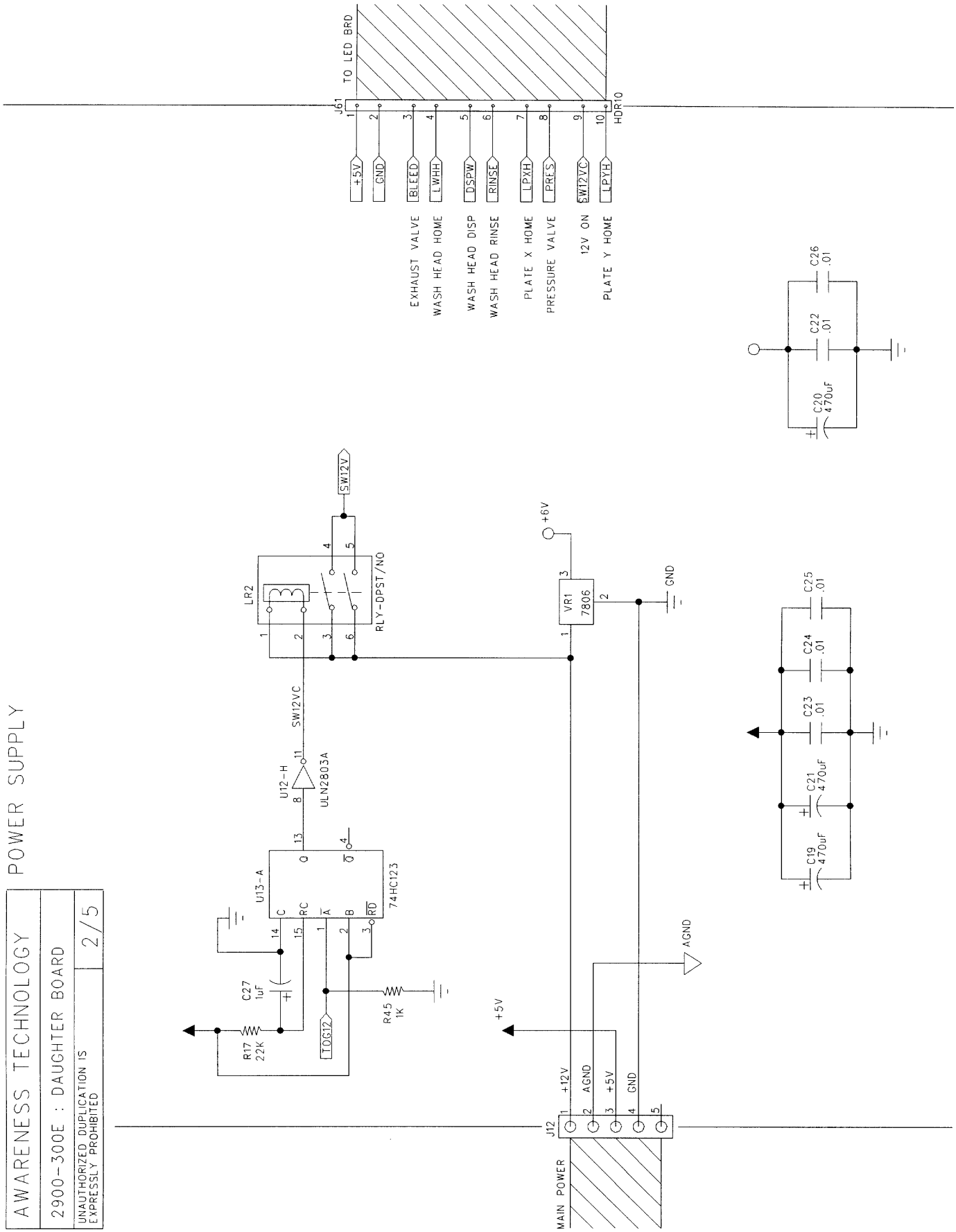
Daughter PCB (2 fo 5)



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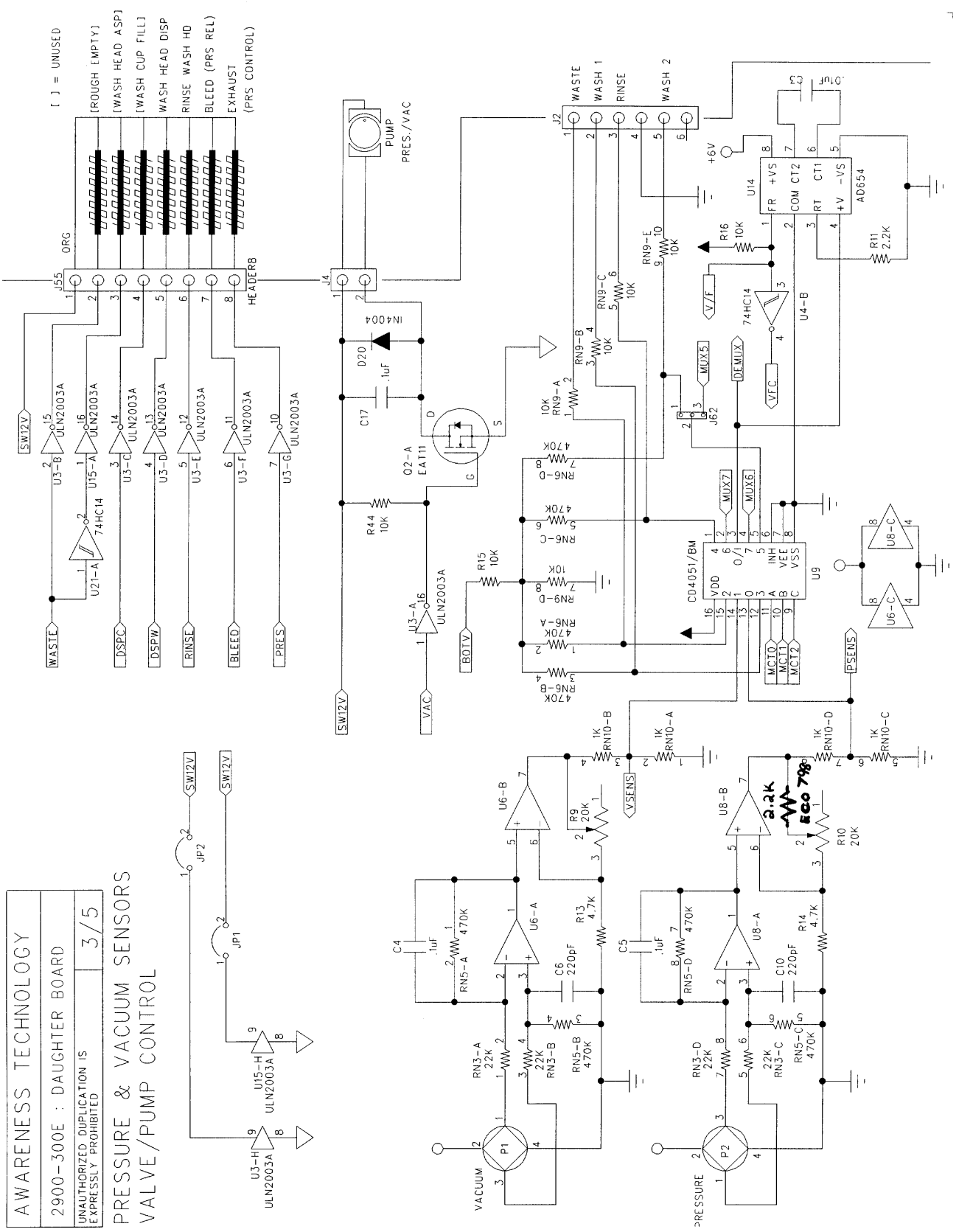
Daughter PCB (3 of 5)



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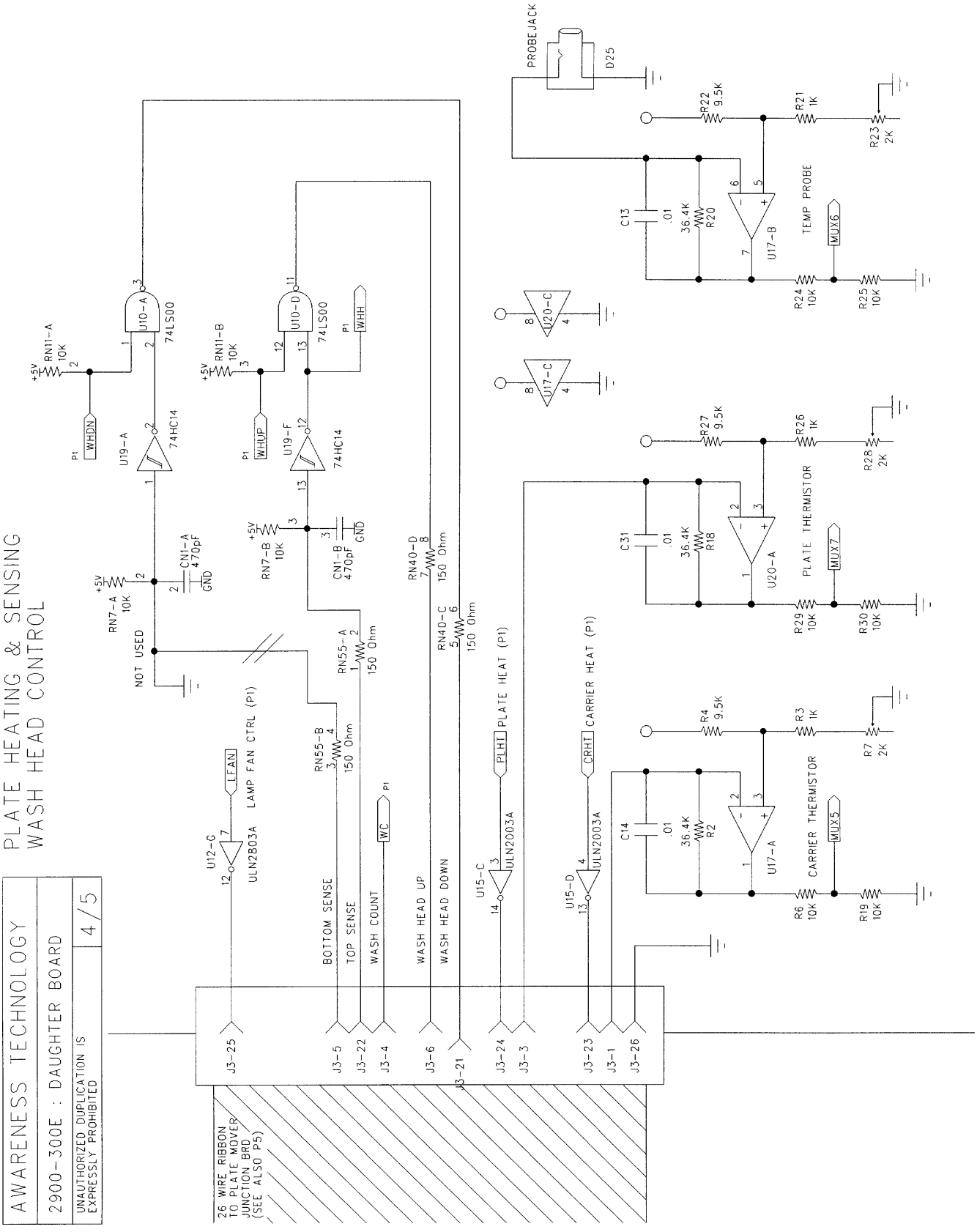
Daughter PCB (4 of 5)



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Daughter PCB (5 of 5)

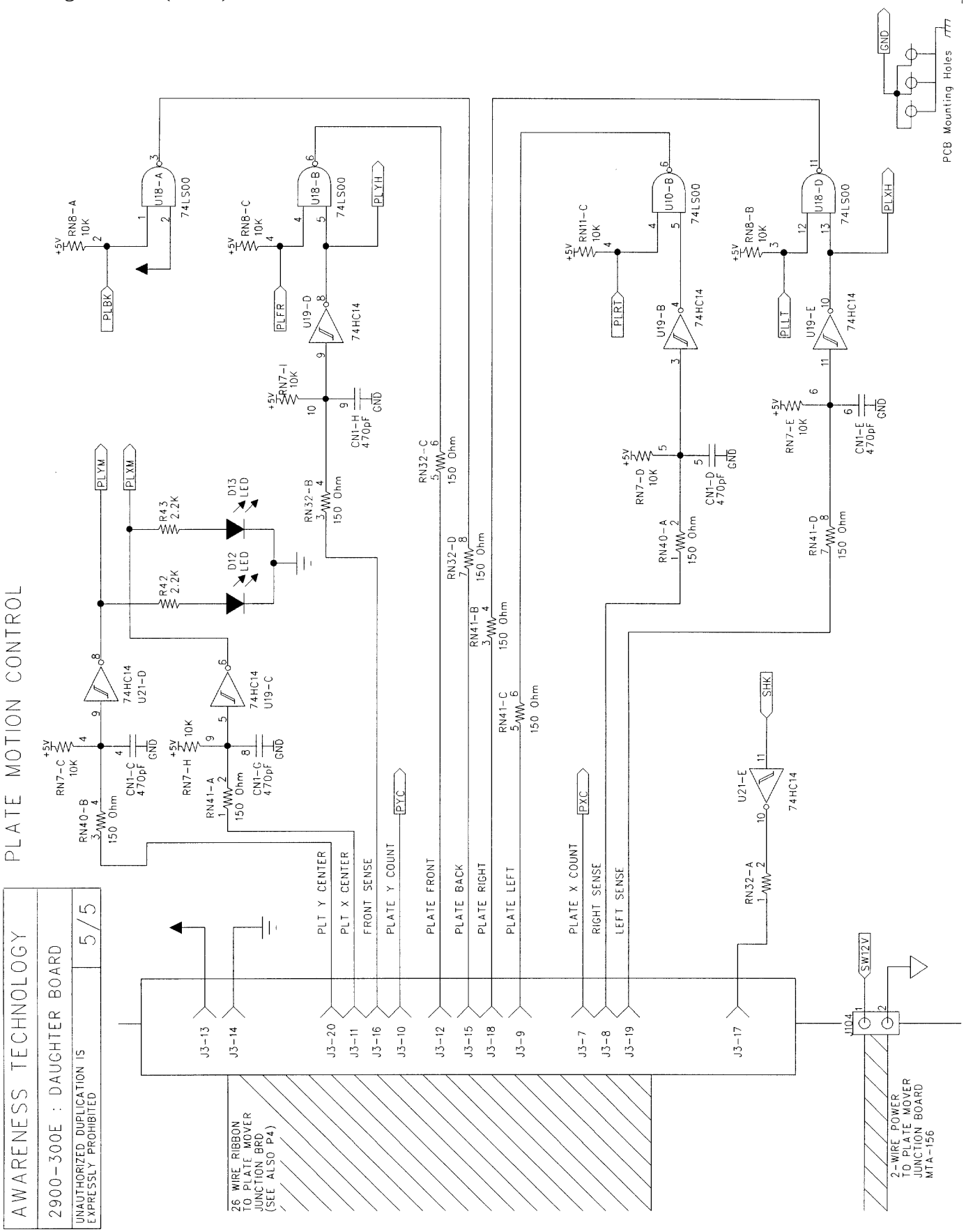

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Plate Mover PCB (1 of 2)

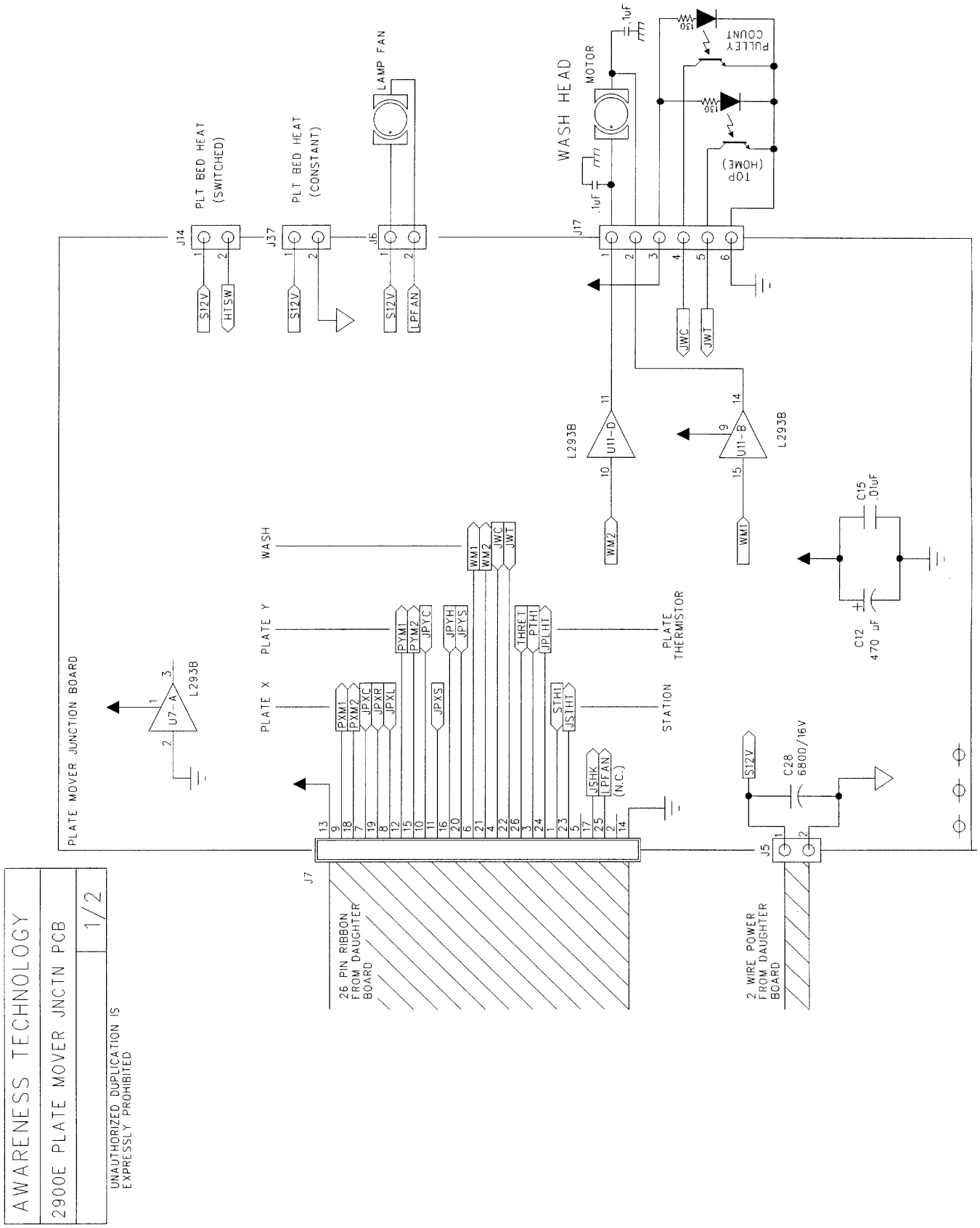

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Plate Mover PCB (2 of 2)

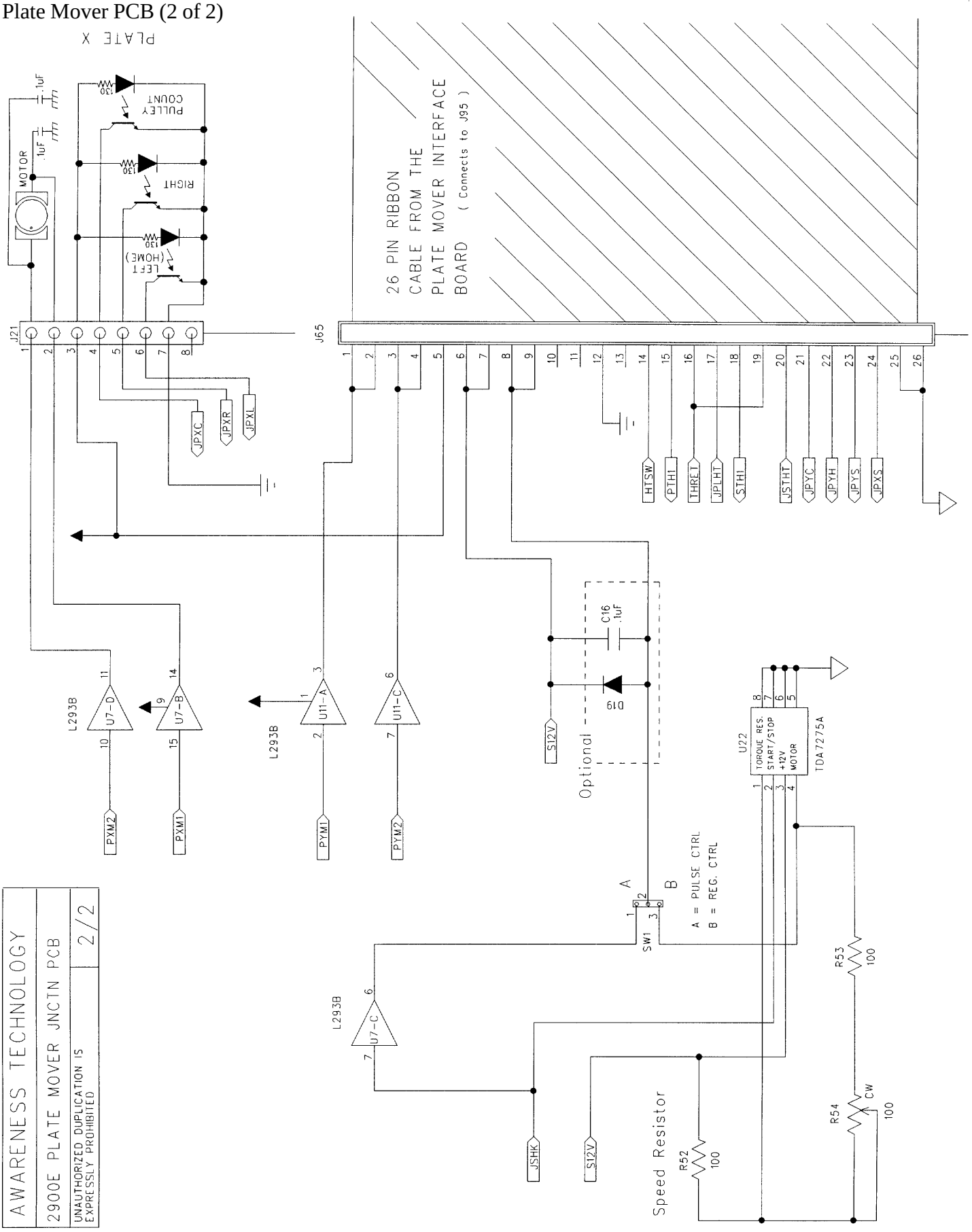

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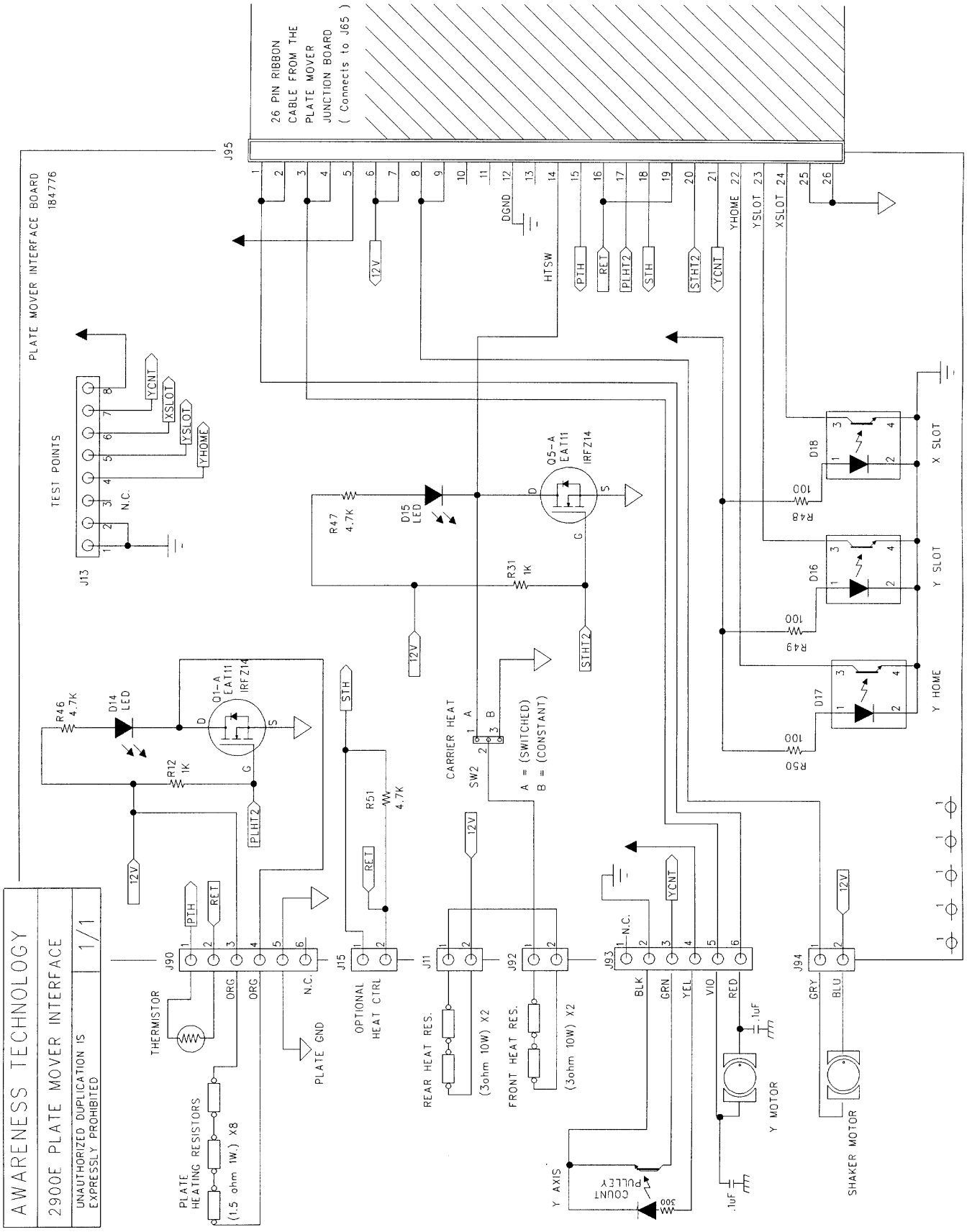
Plate Mover Interface PCB



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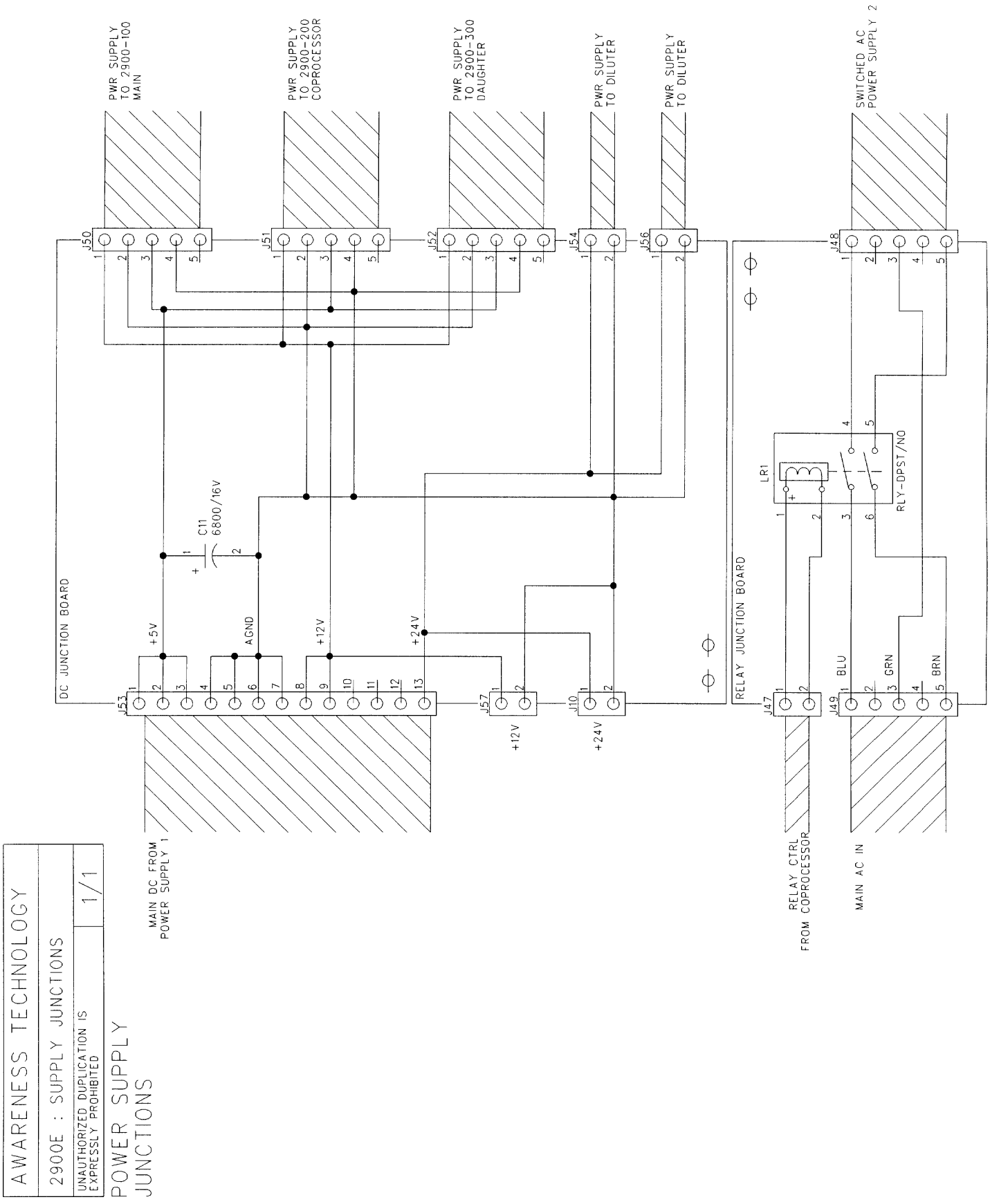
DC Power Junction PCB



AWARENESS TECHNOLOGY
2900E : SUPPLY JUNCTIONS
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1/1
POWER SUPPLY JUNCTIONS

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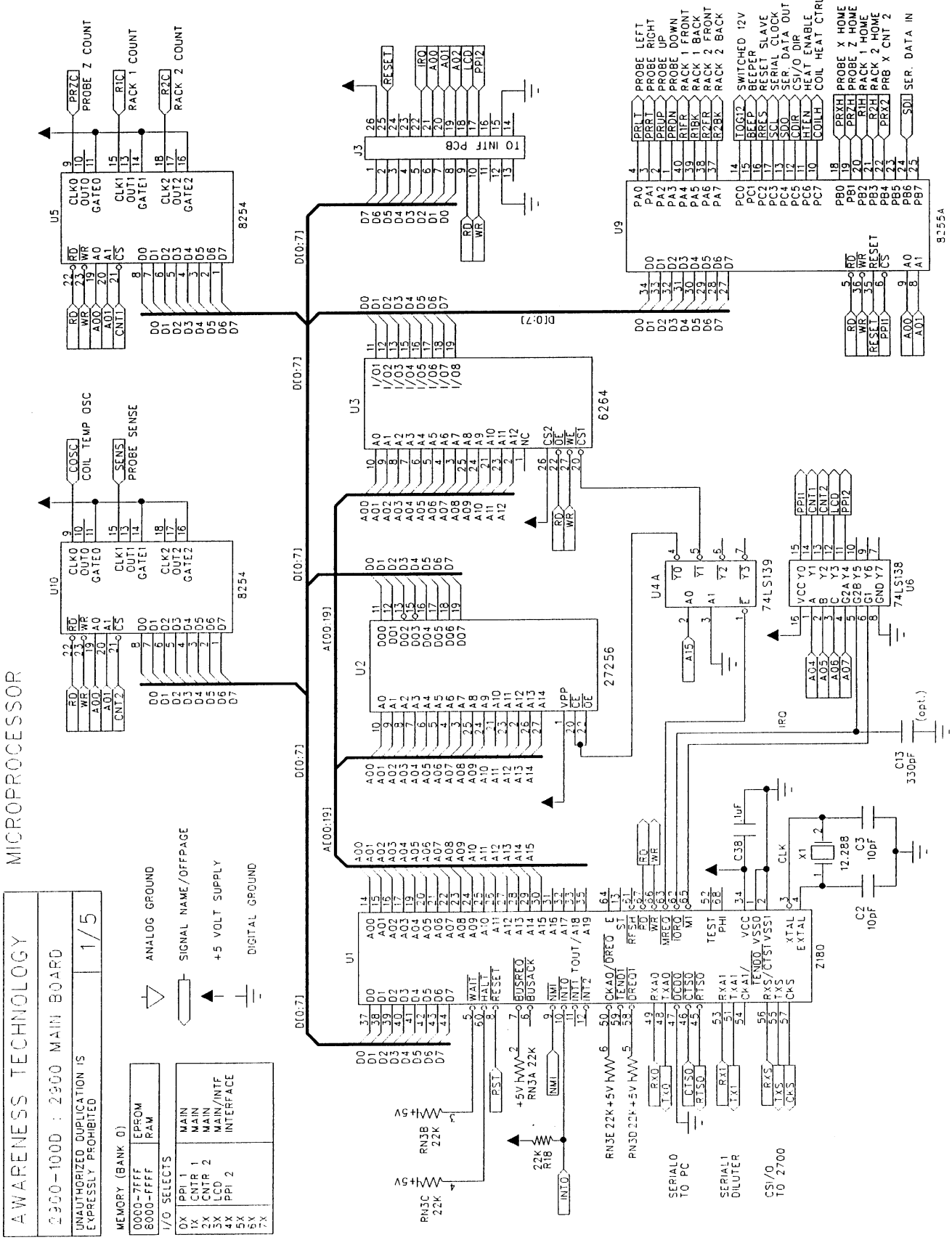
Rev. D Boards

Main PCB (1 of 5)



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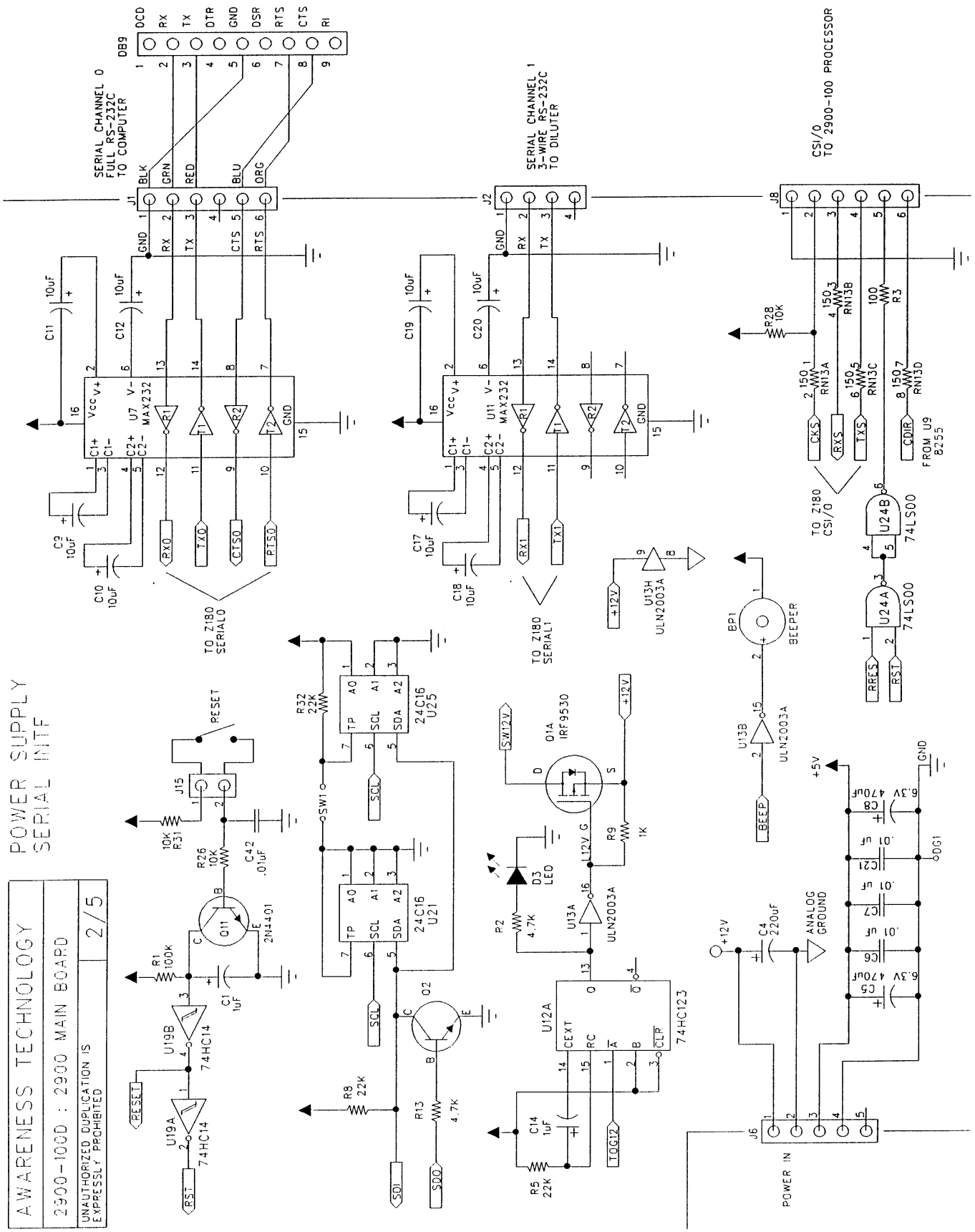
Main PCB (2 of 5)



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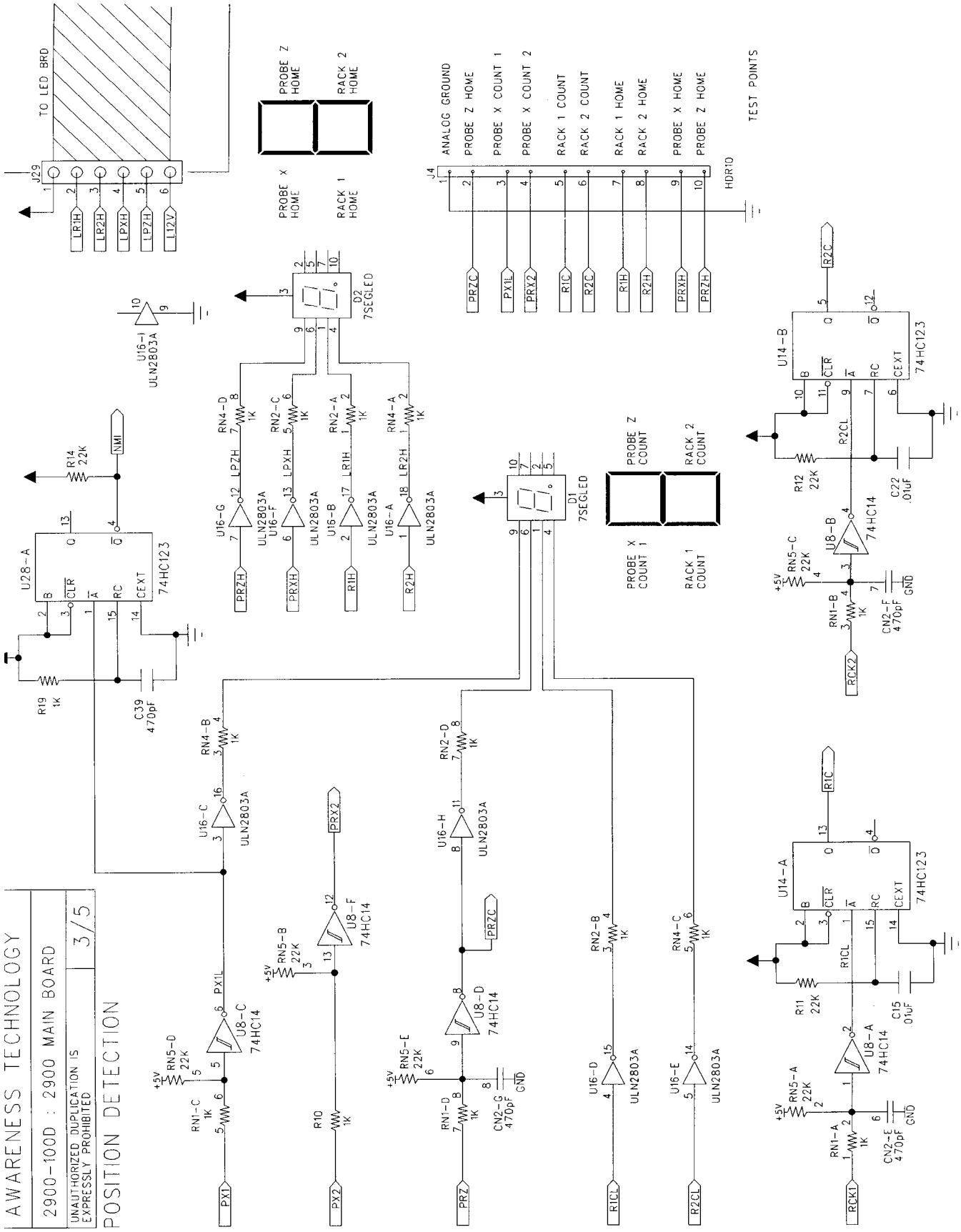
Main PCB (3 of 5)



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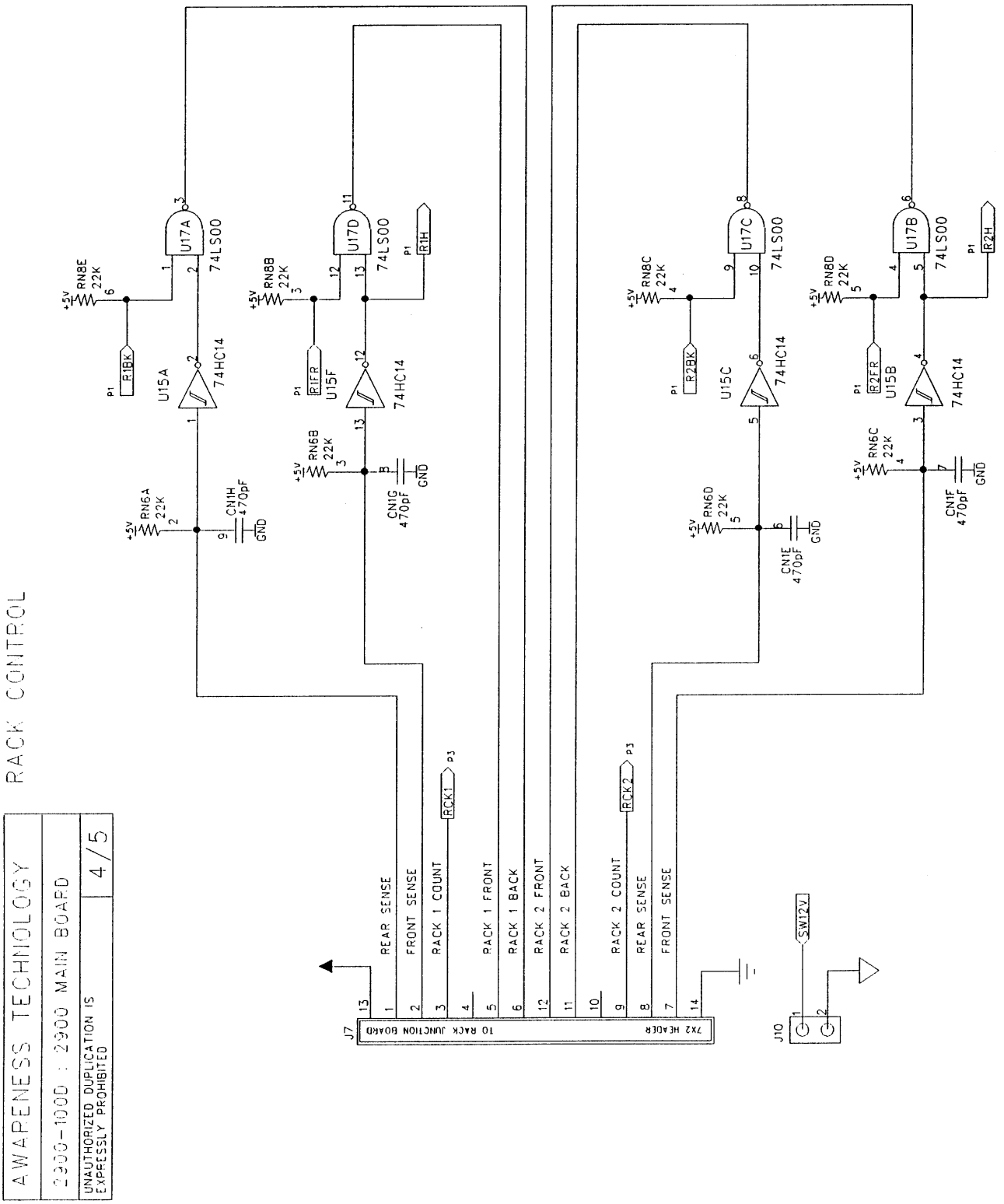
Main PCB (4 of 5)



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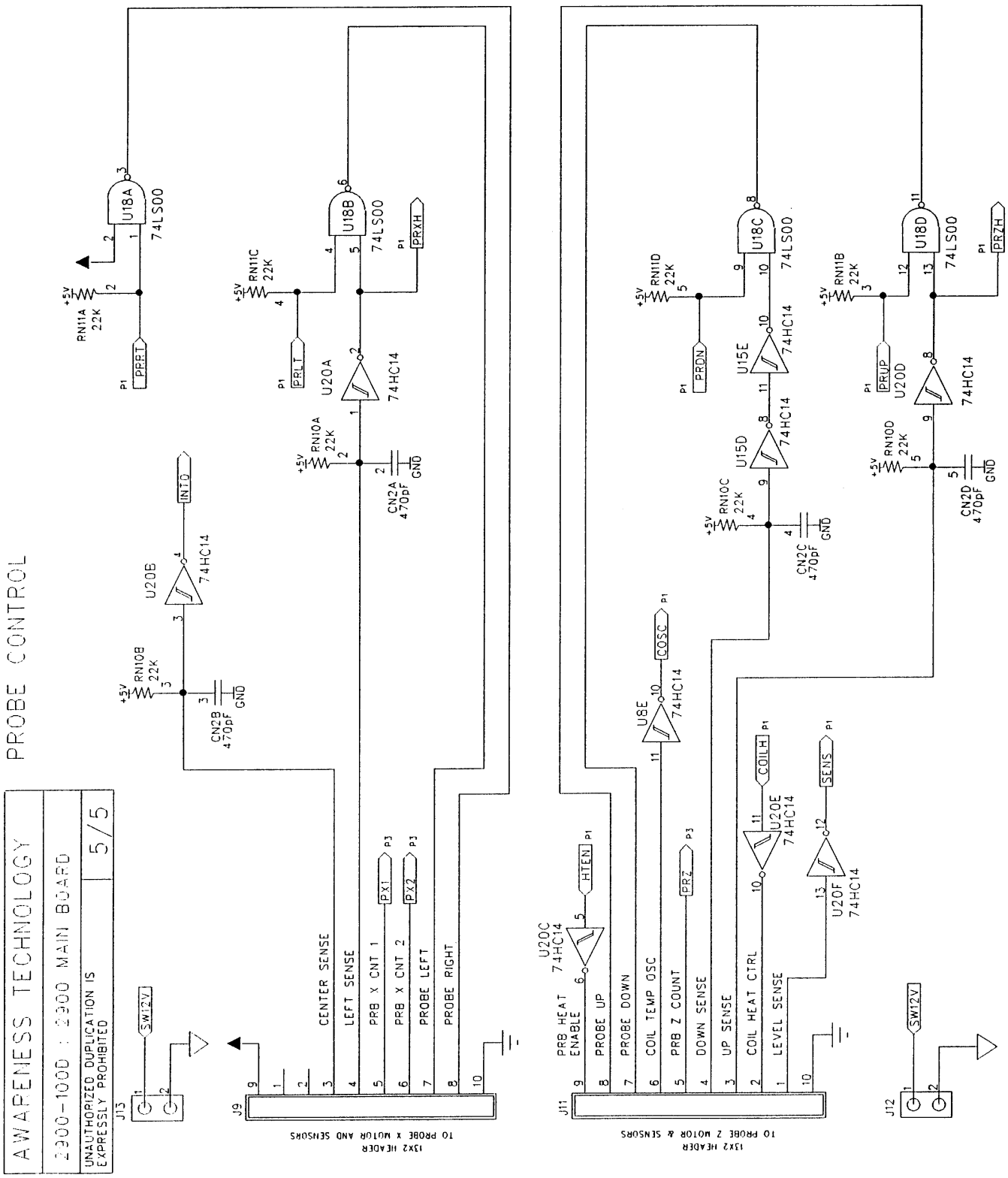
Main PCB (5 of 5)



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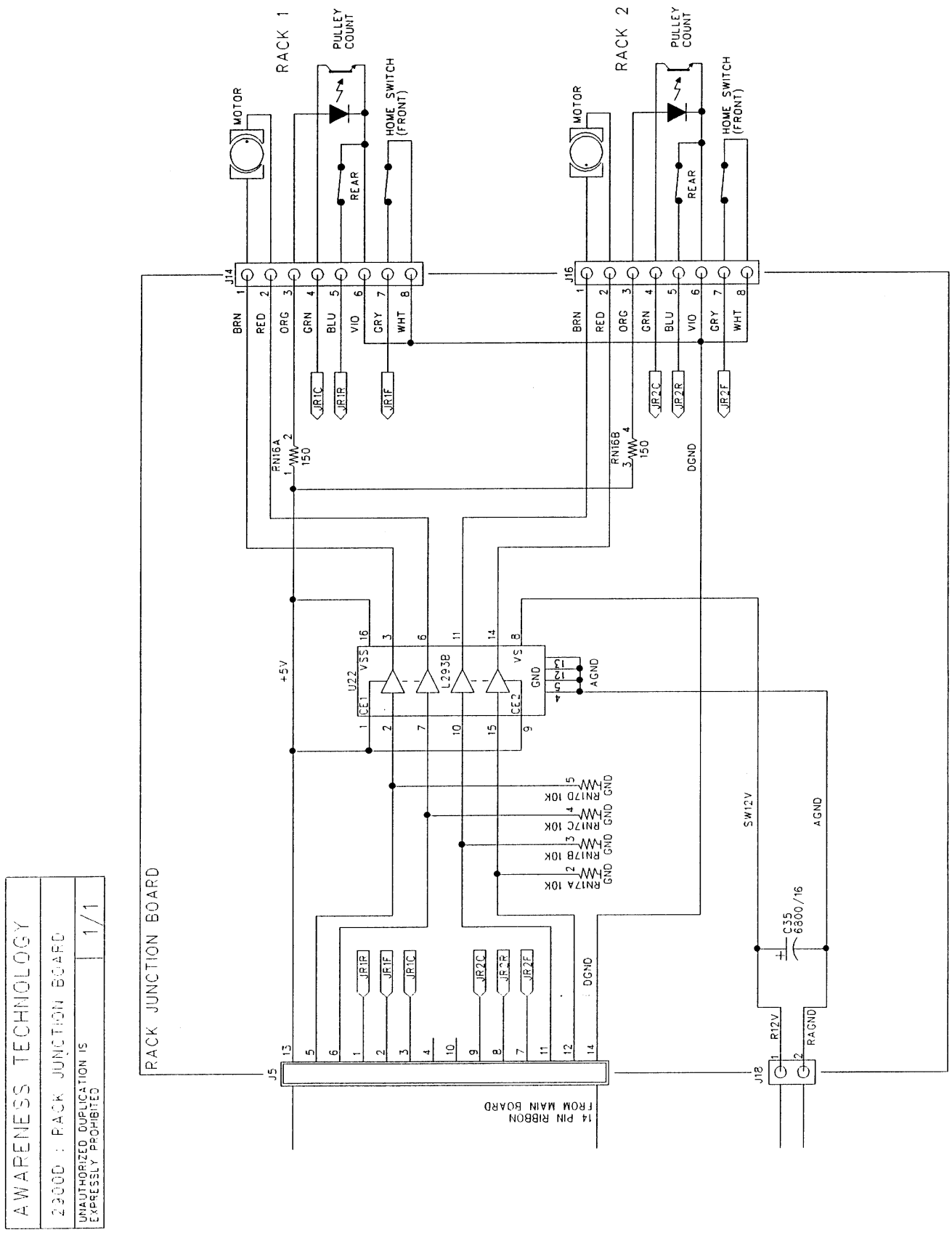
Rack Junction PCB (1 of 1)



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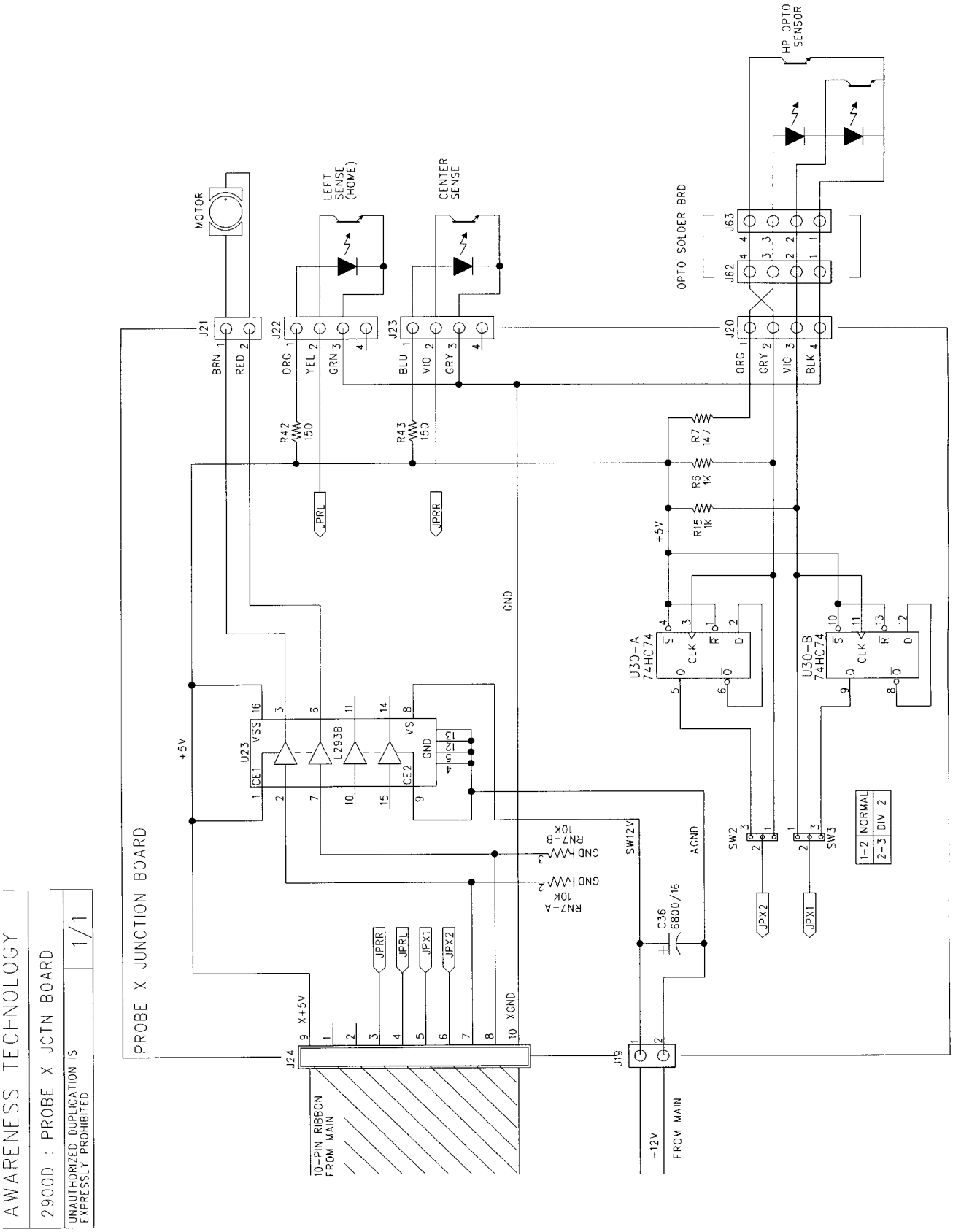
Probe X Junction PCB (1 of 1)



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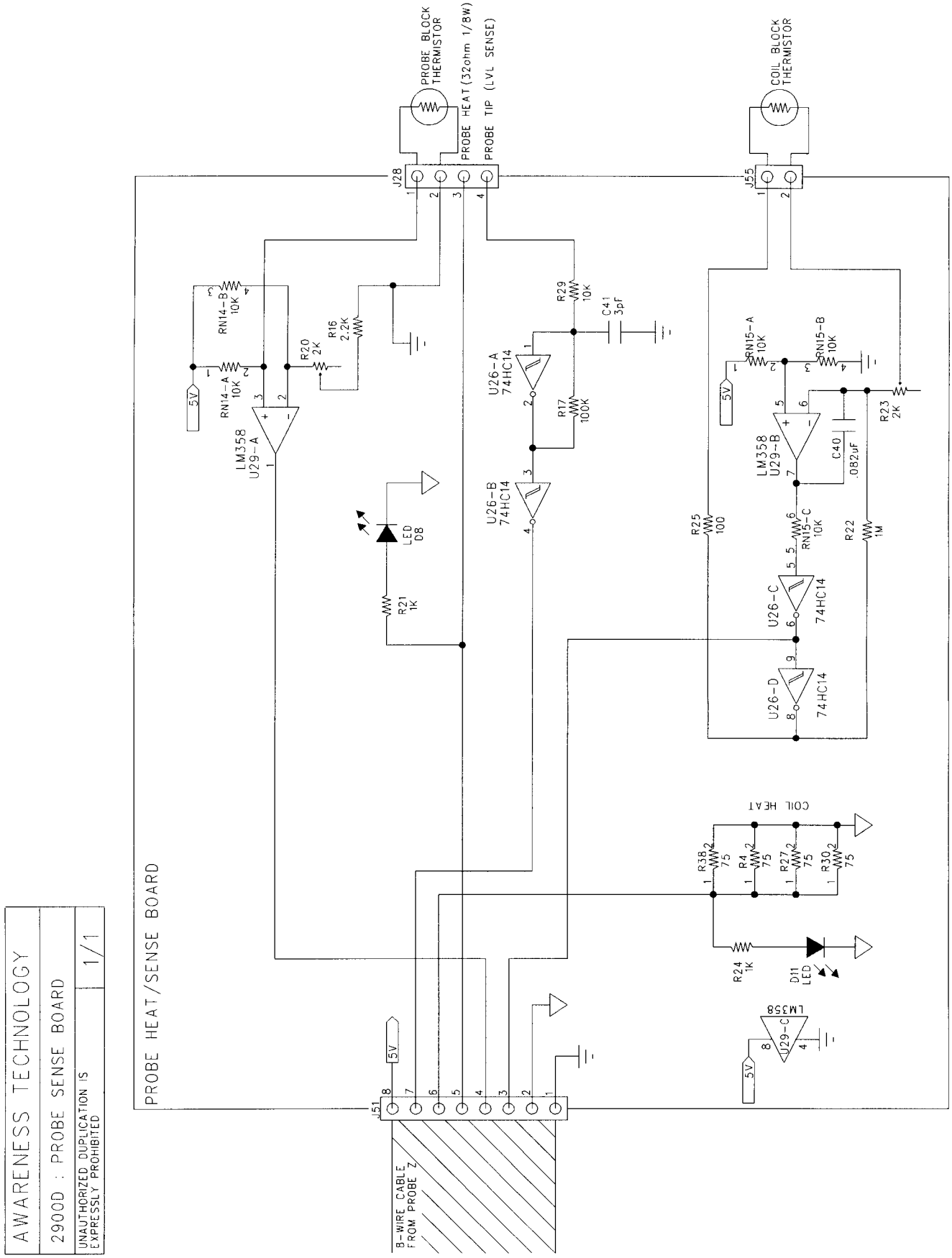
Probe Sense/ Heater Control PCB (1 of 1)



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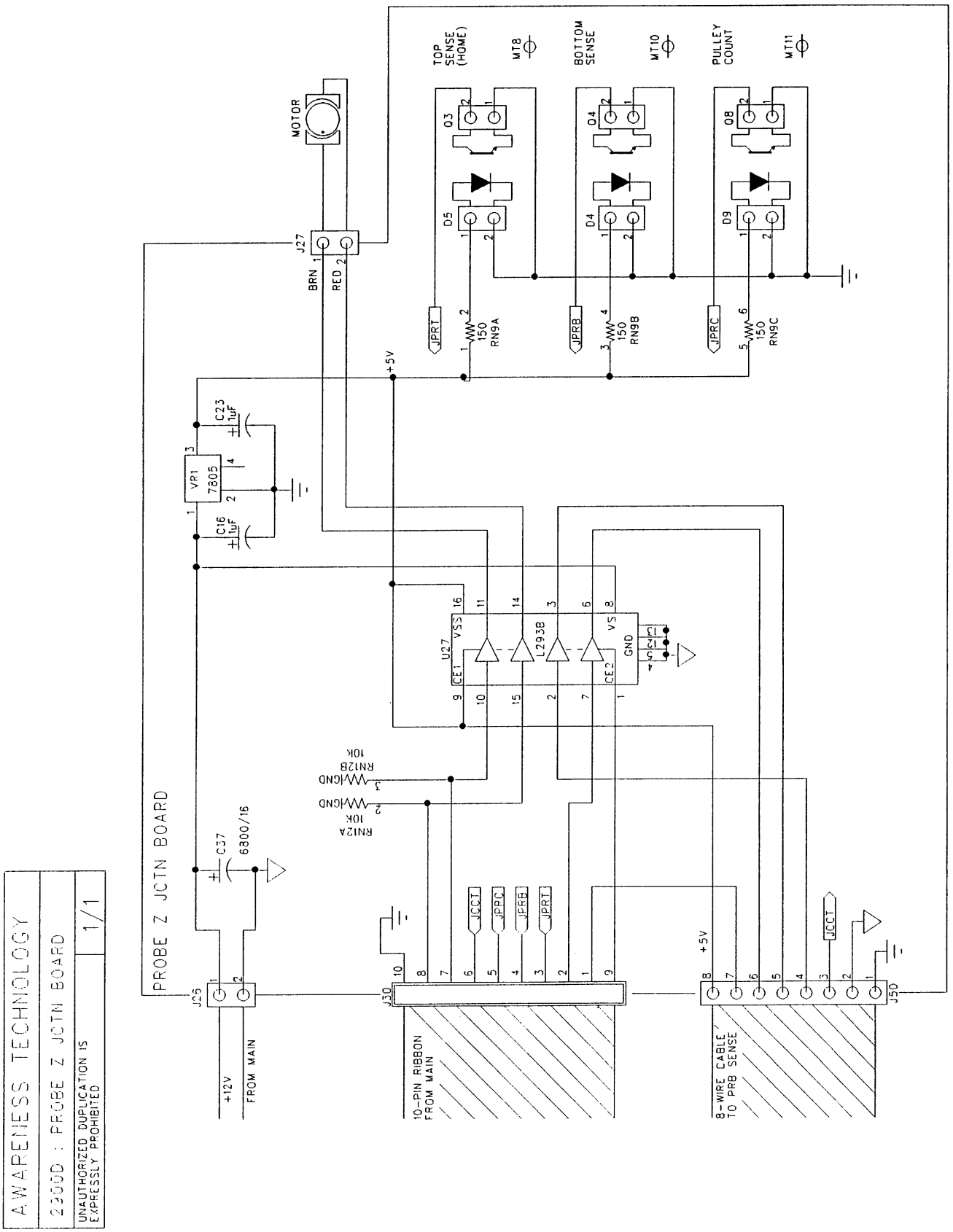
Probe Z Junction PCB (1 of 1)



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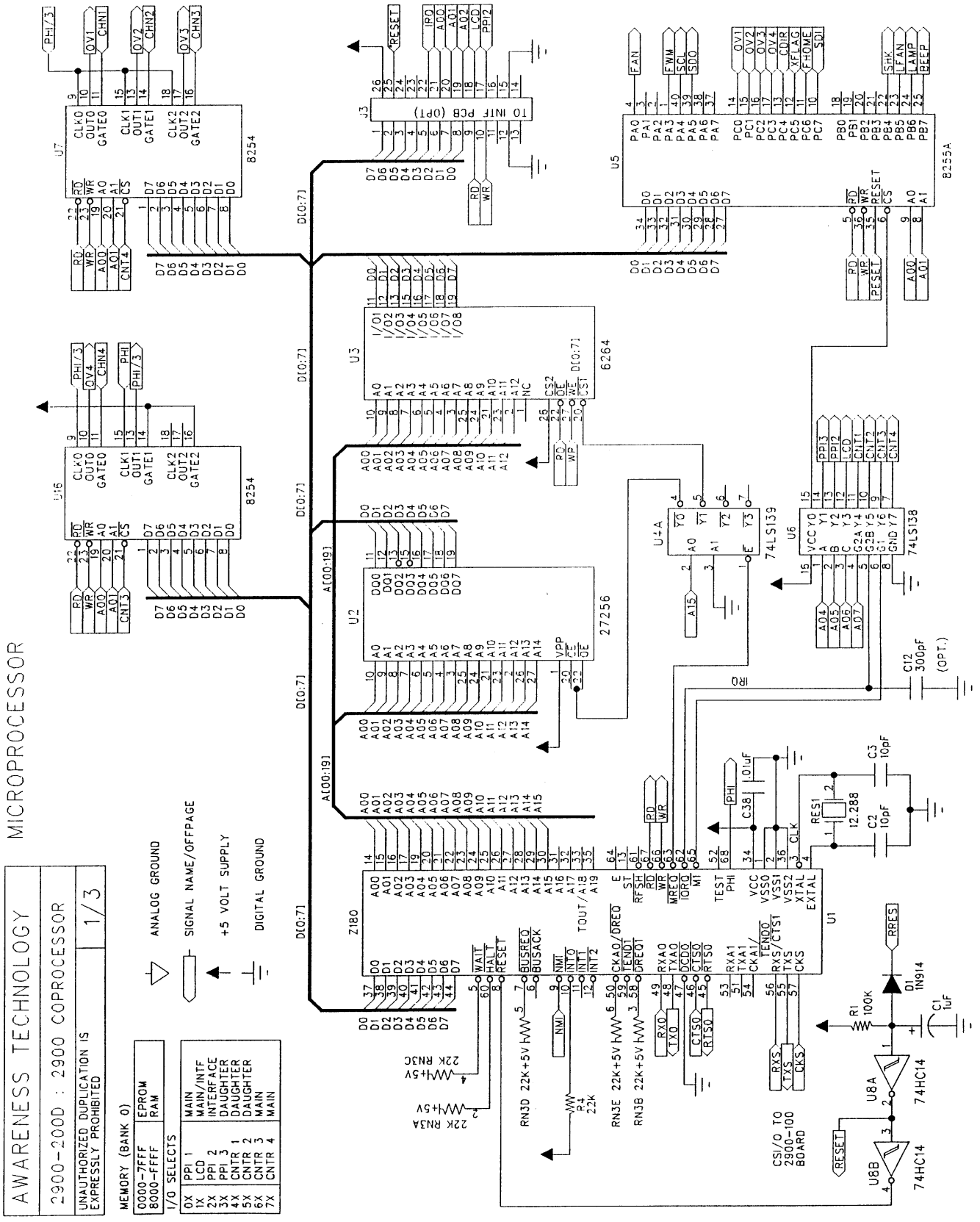
Coprocessor PCB (1 of 3)



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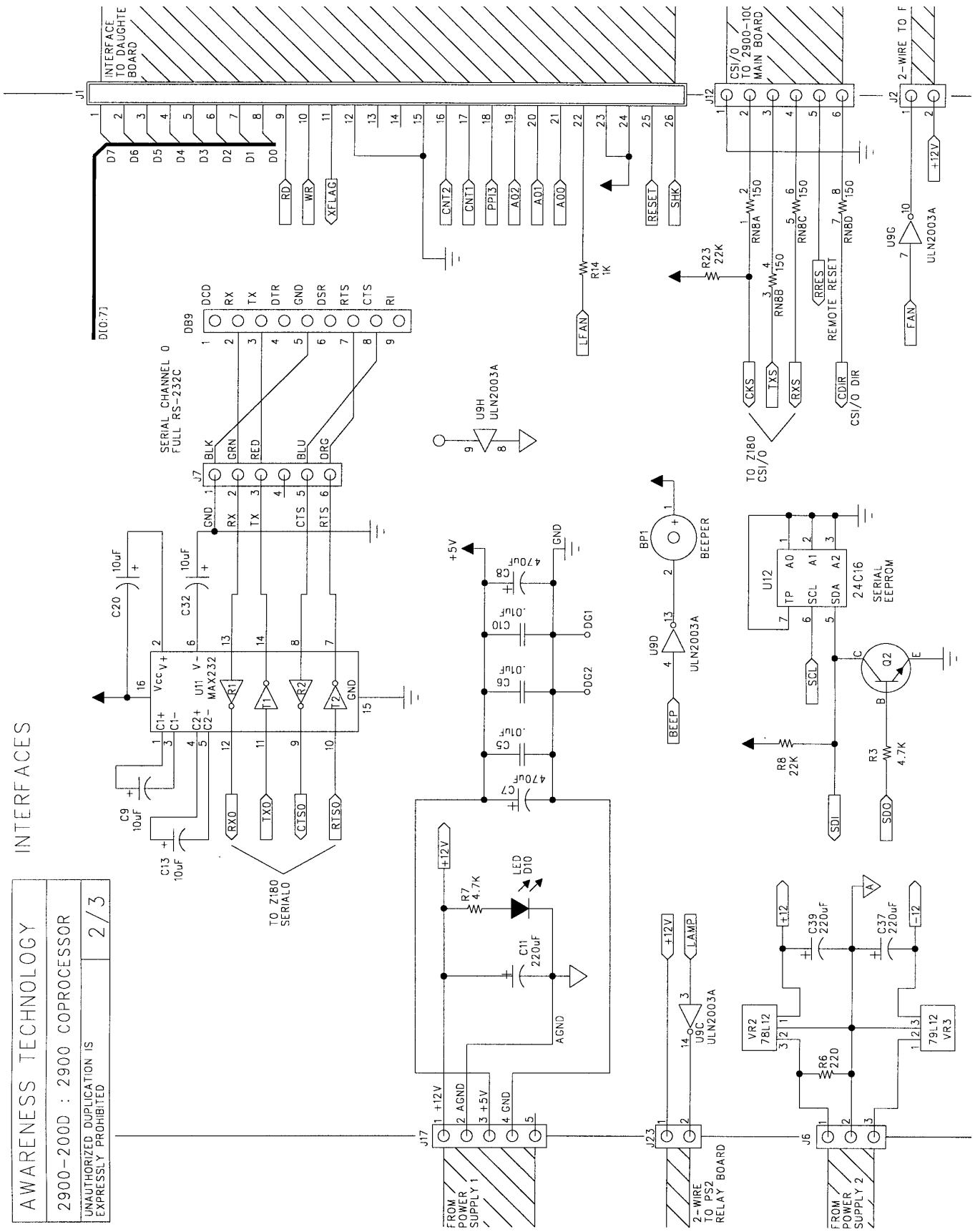
Coprocessor PCB (2 of 3)



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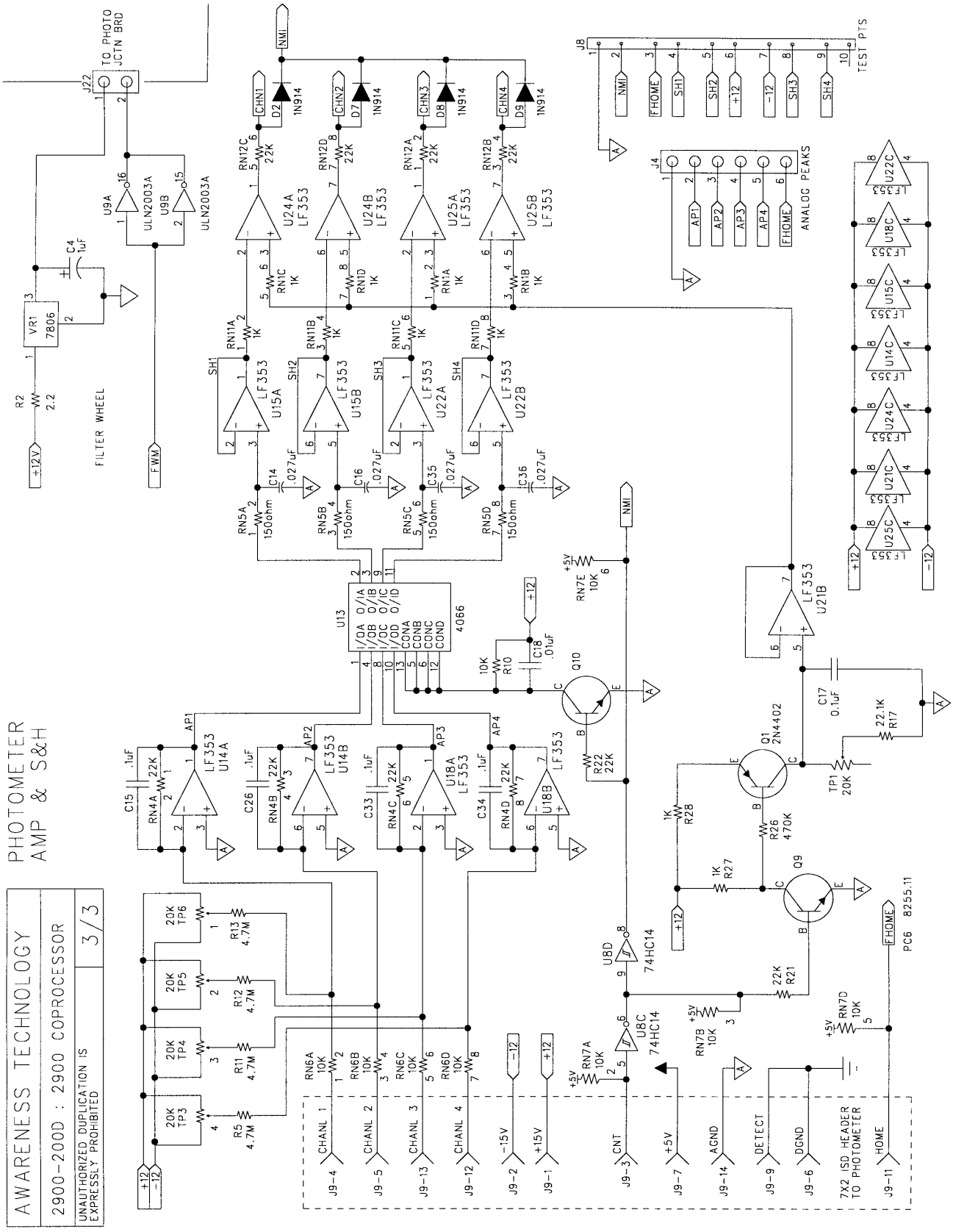
Coprocessor PCB (3 of 3)



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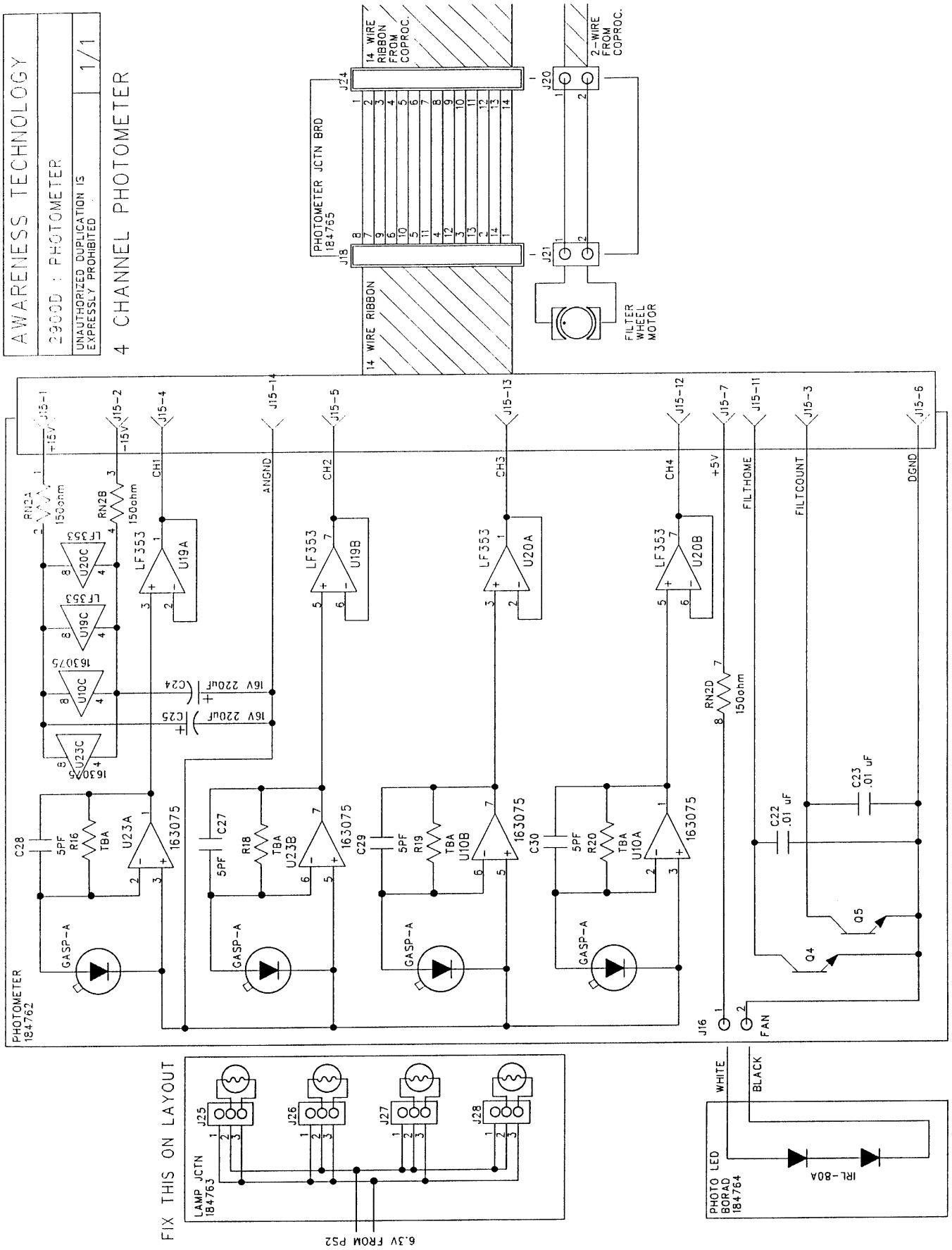
Photometer PCB (1 of 1)



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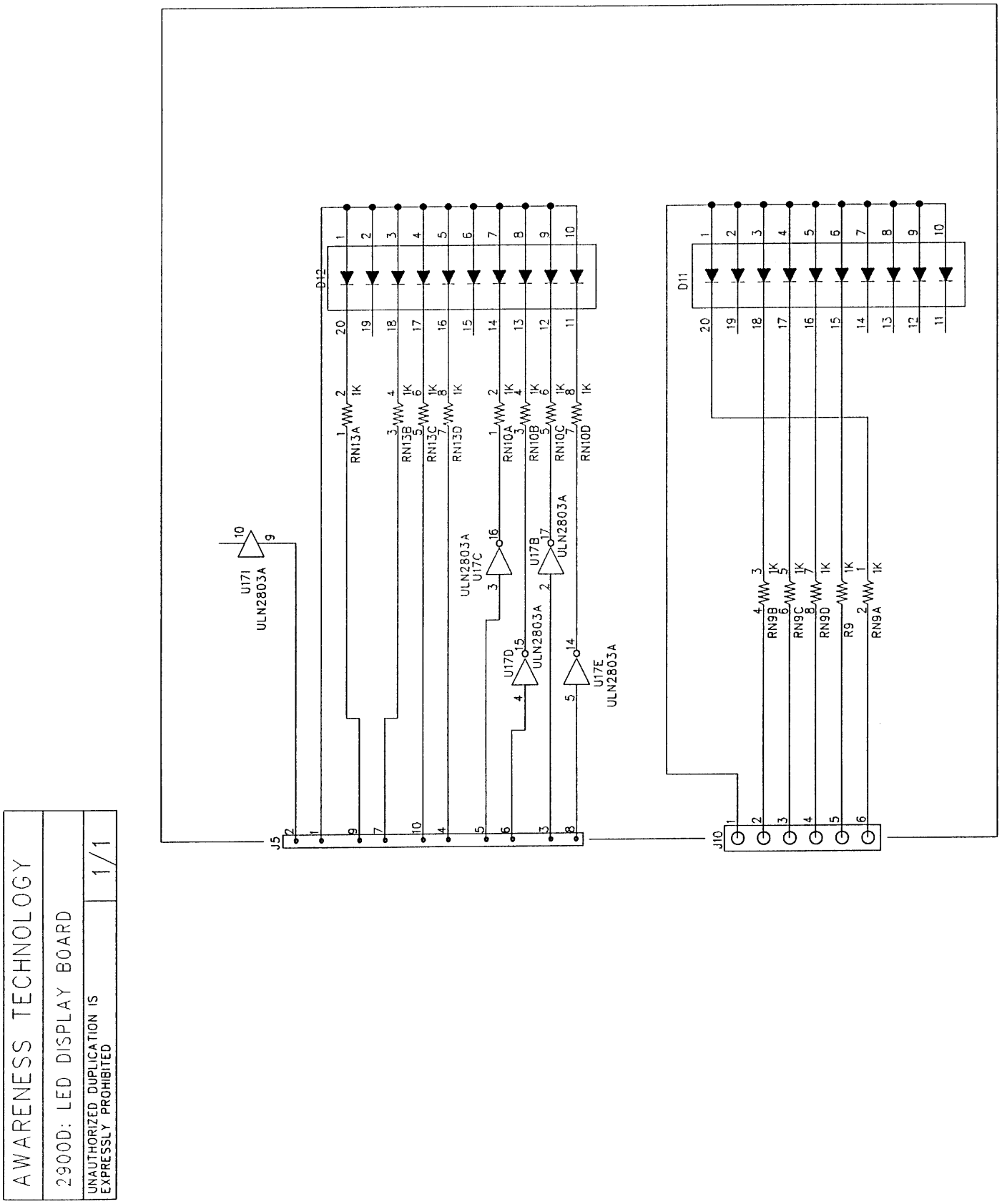
LED Display PCB (1 of 1)



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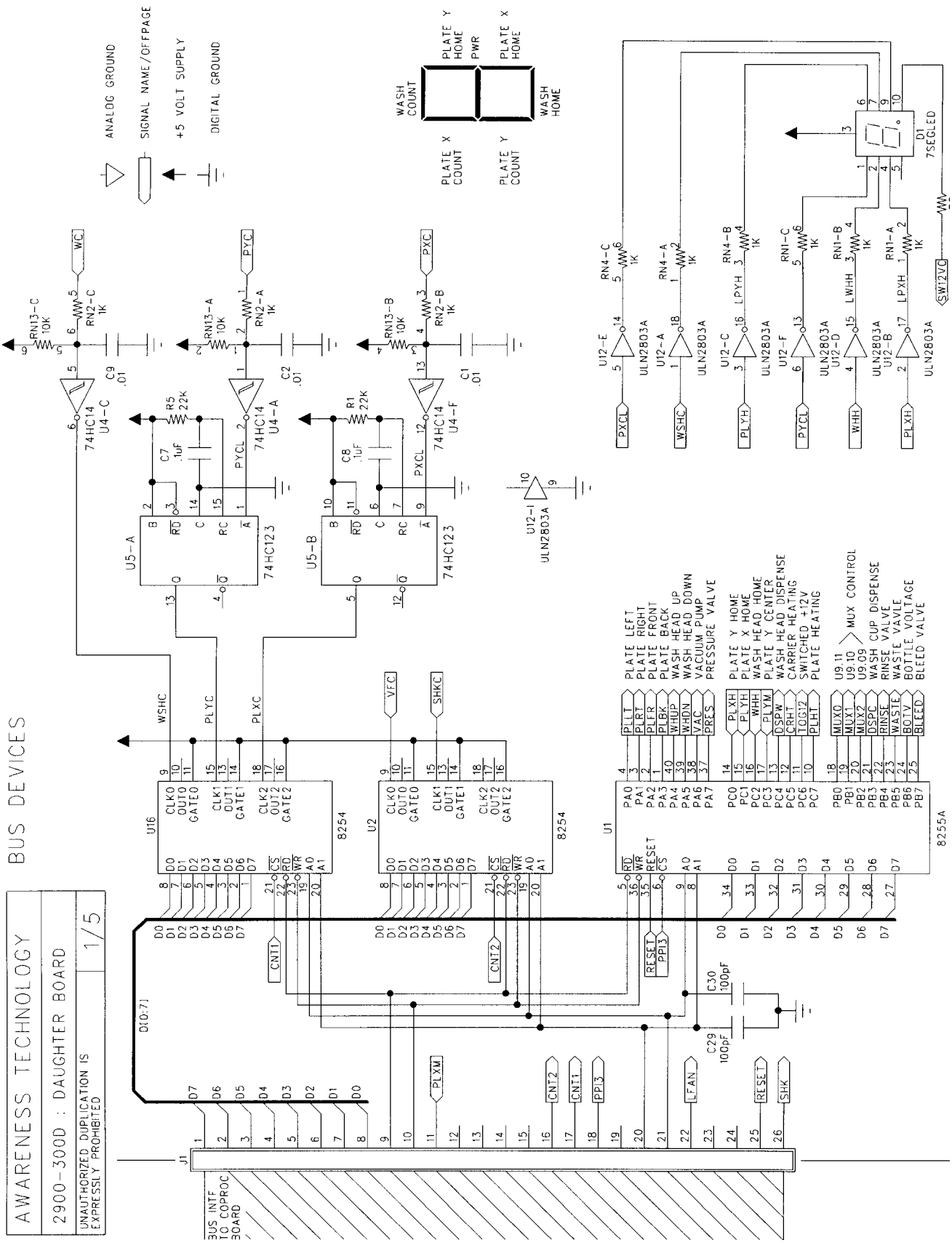
Daughter PCB (1 of 5)



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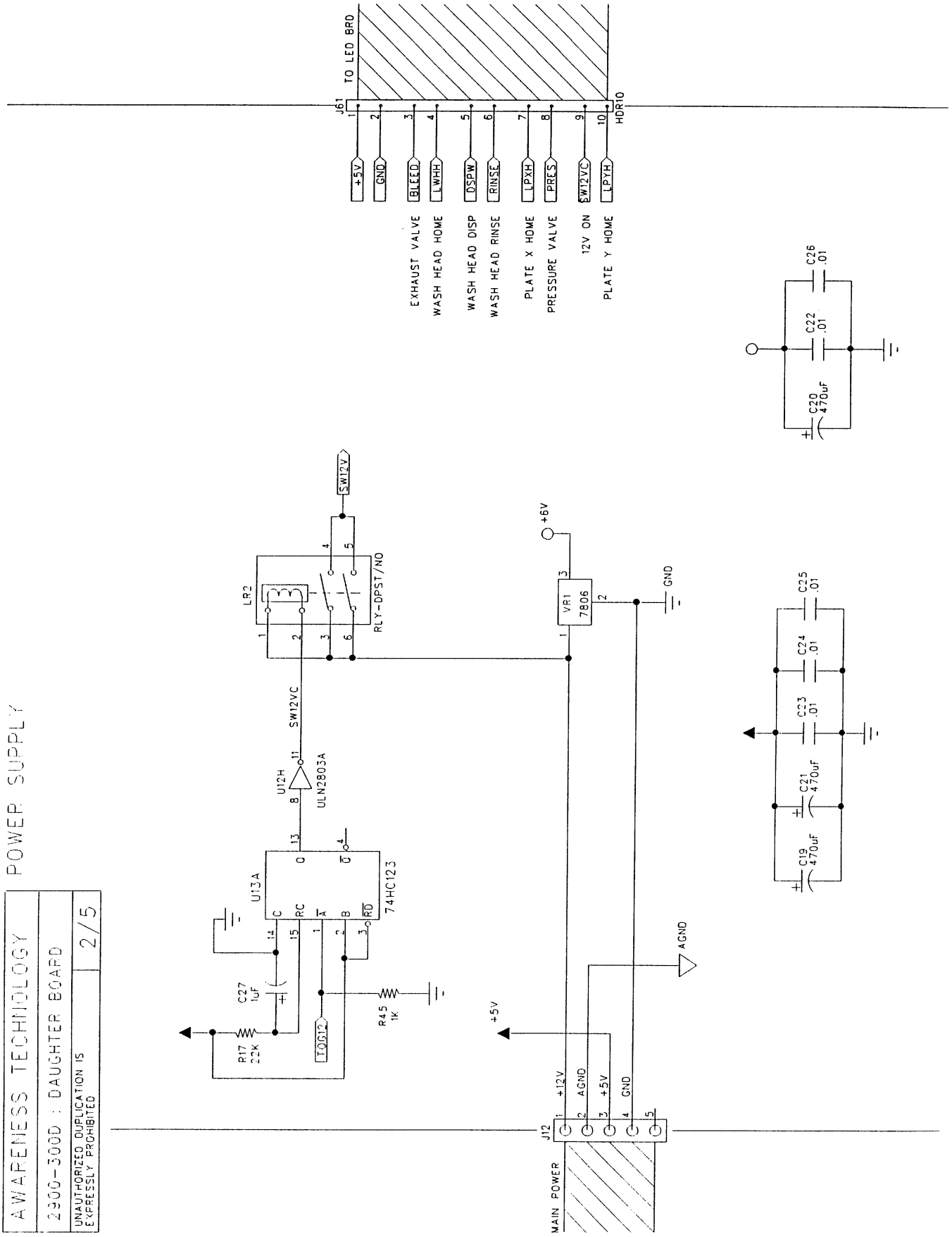
Daughter PCB (2 of 5)



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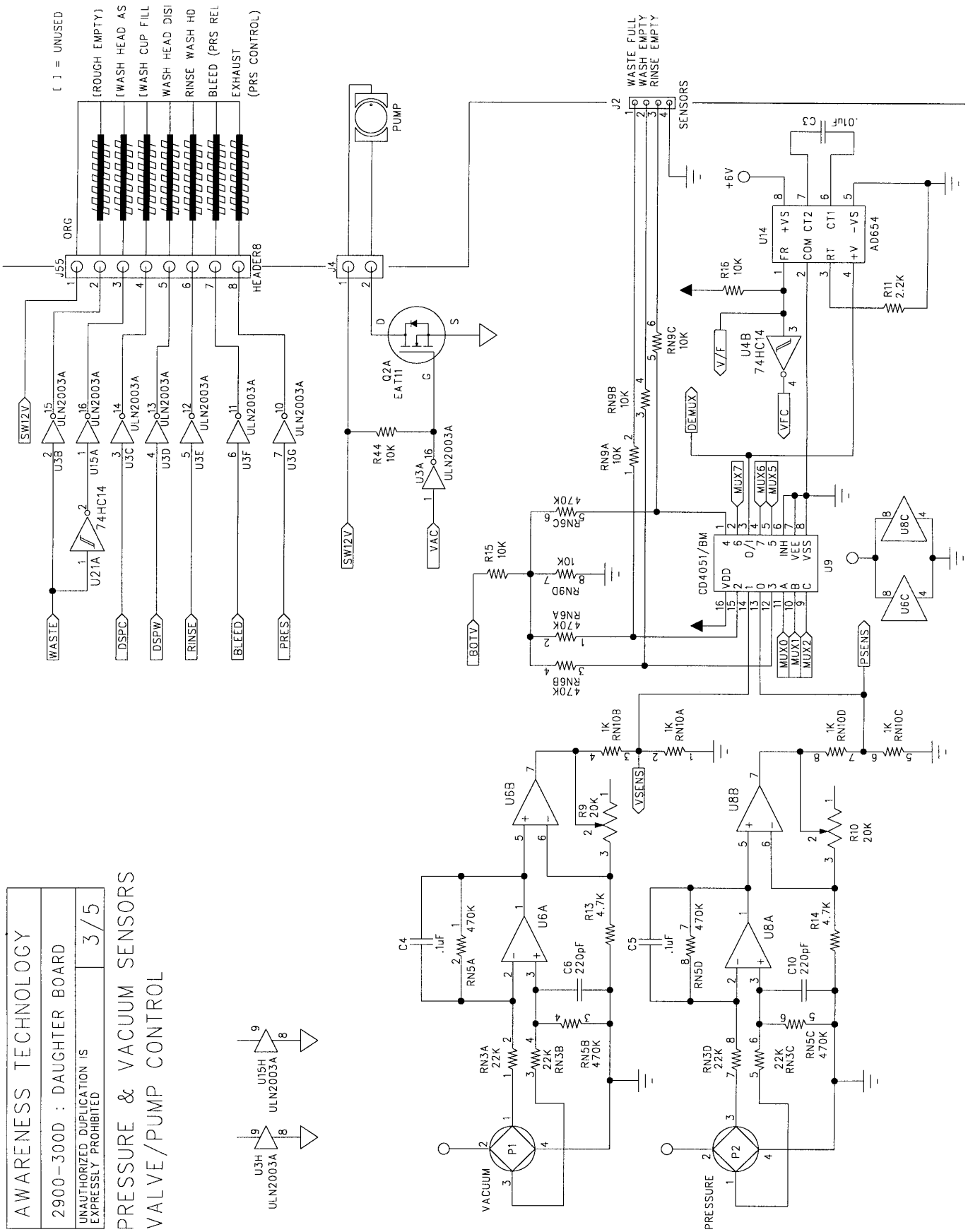
Daughter PCB (3 of 5)



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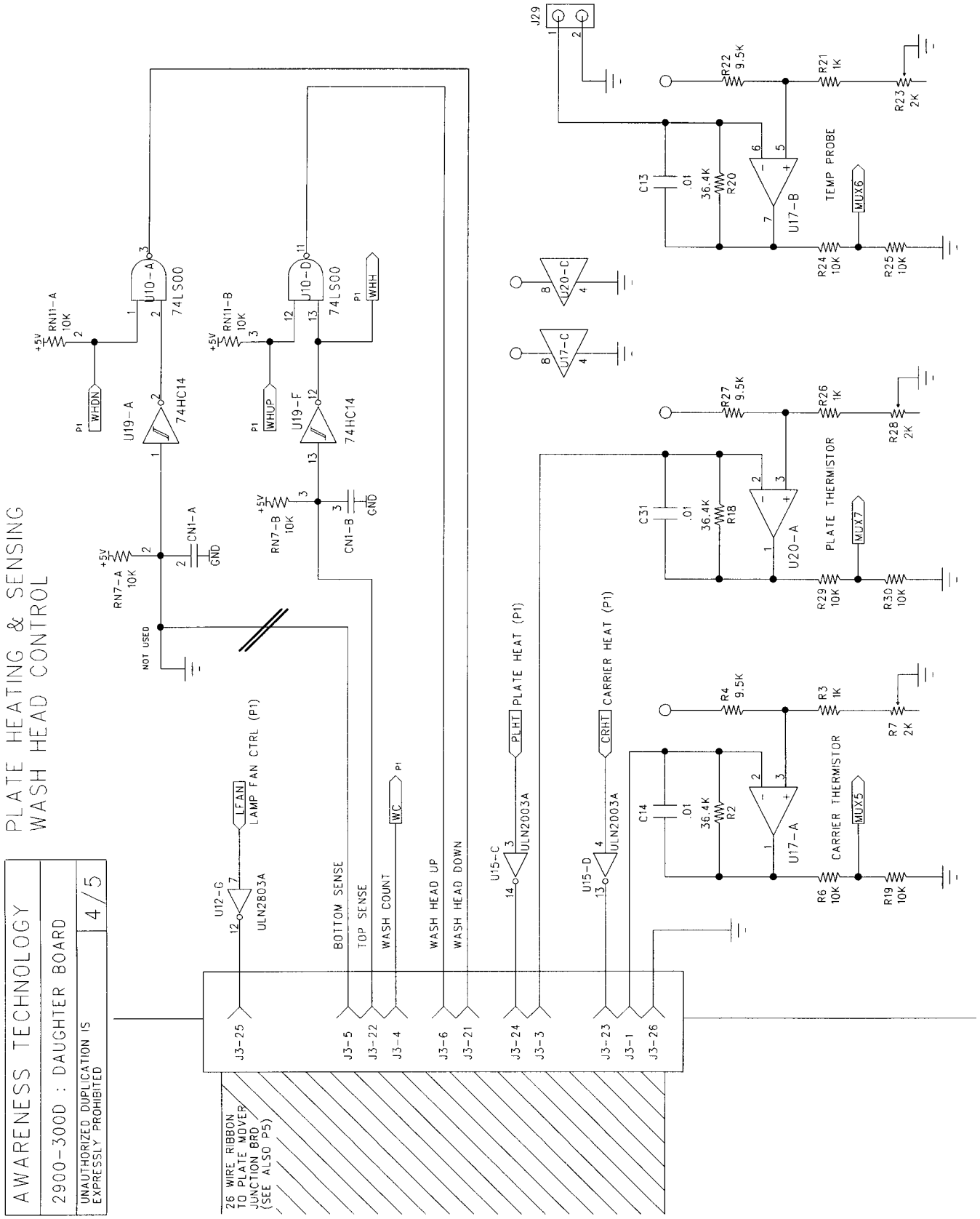
Daughter PCB (4 of 5)



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Daughter PCB (5 of 5)

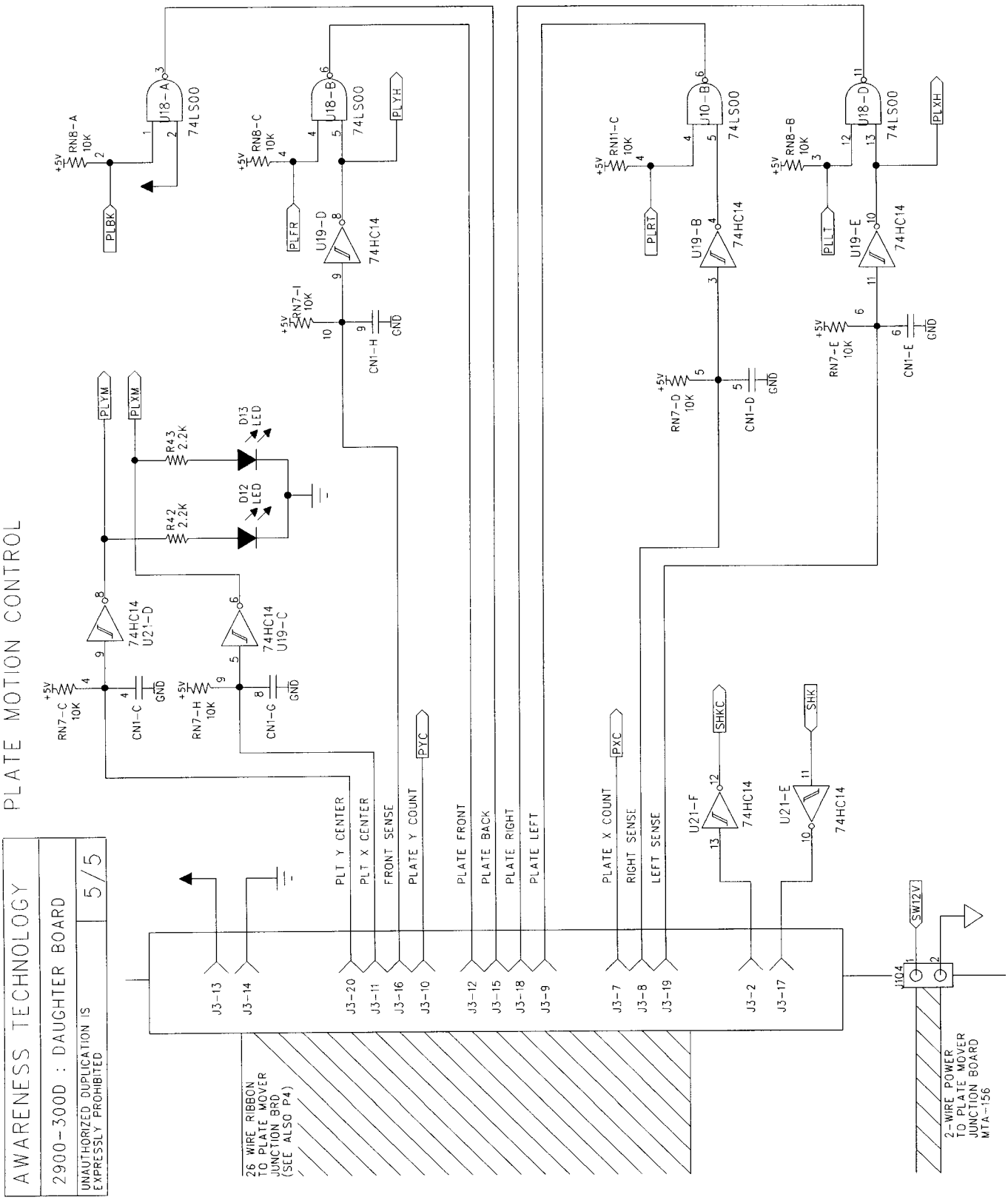

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Plate Mover PCB (1 of 2)

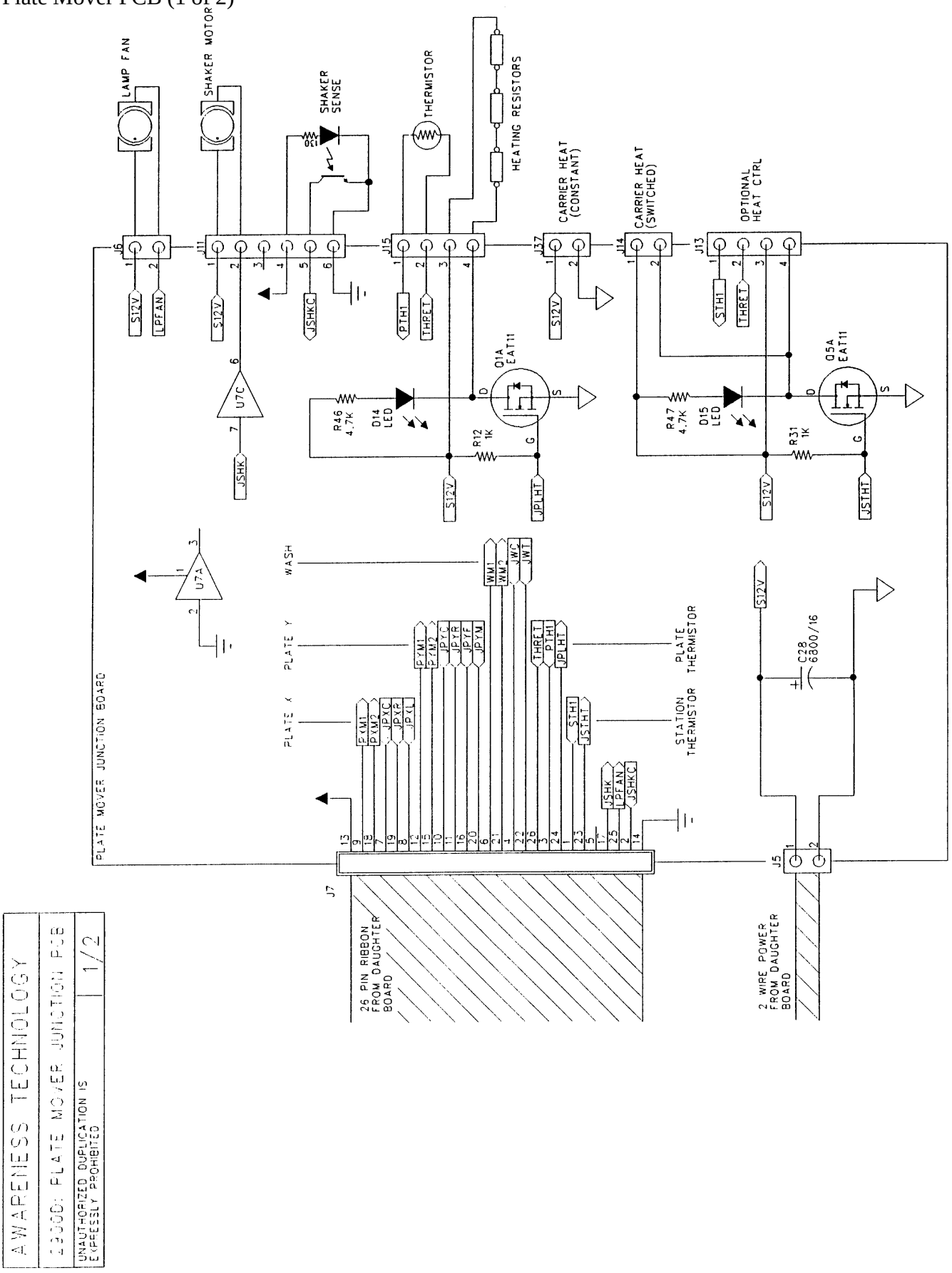

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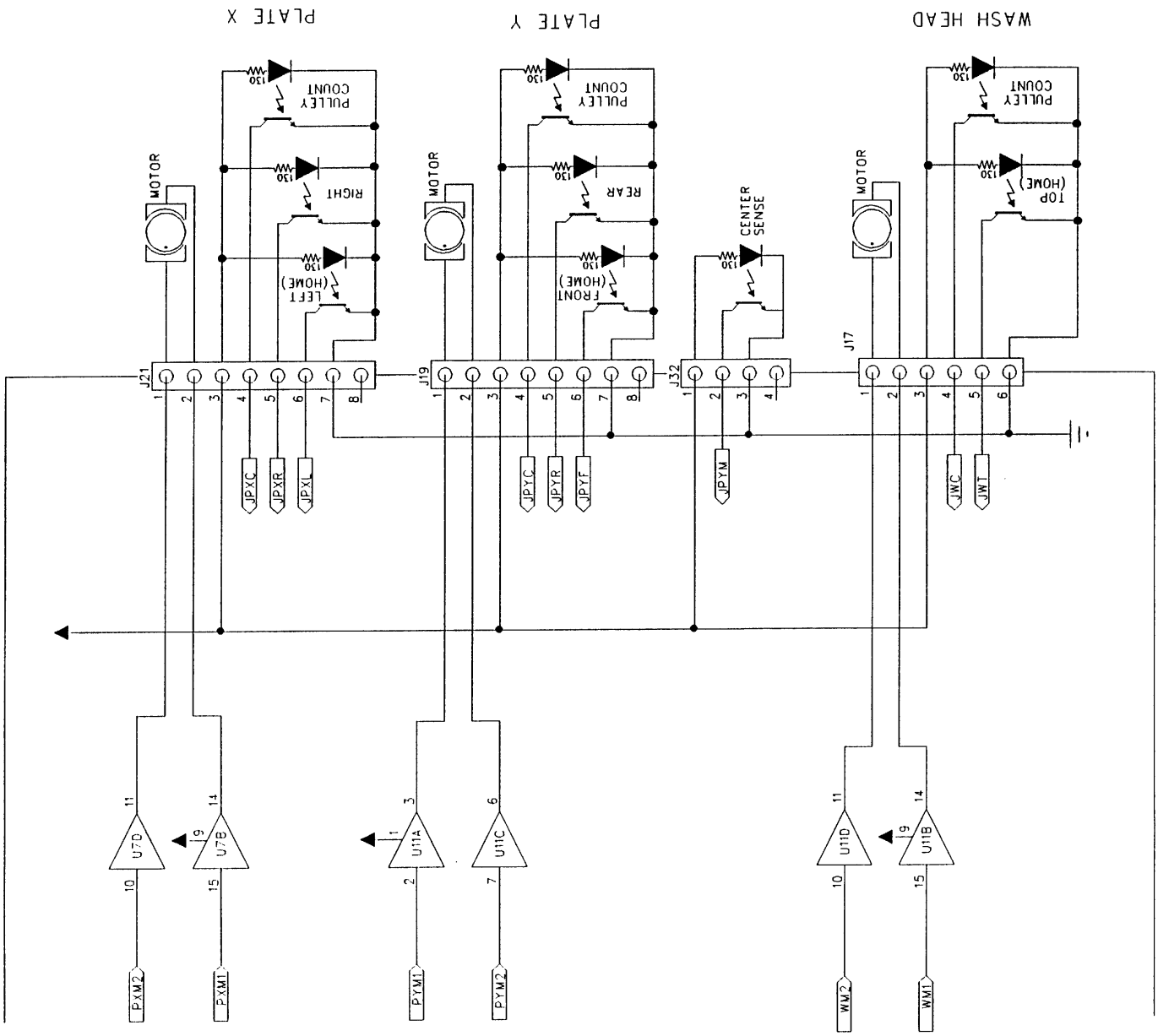
Plate Mover PCB (2 of 2)



AWARENESS TECHNOLOGY	
2900: PLATE MOVER JUNCTION PCB	2/2
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Appendix G- Contact Information

If you continue to have problems after consulting your dealer, contact the factory.

Phone: USA 561-283-6540
Fax: USA 561-283-8020
e-mail: chemwell-support@awaretech.com
Mailing Address: Awareness Technology, Inc.
P.O. Drawer 1679
Palm City, FL. 34991
USA

When contacting us, please have serial number of the ChemWell in question. Have a description of the problem with as much detail as possible. Save any relevant jobs or logs to disk (See File Management\ Using ChemWell Pack) and send or e-mail us the information.

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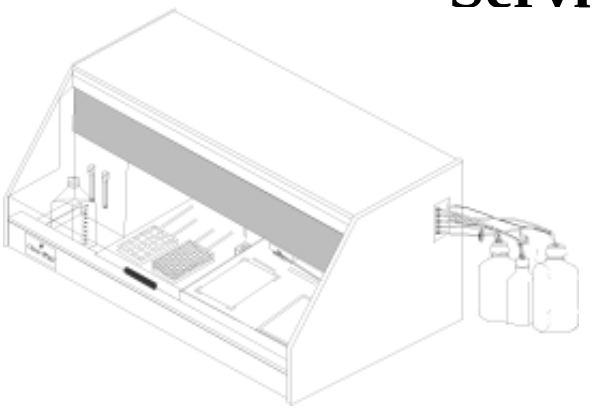
2900 Series

Service Manual



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